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Metallurgical & Chemical Engineering

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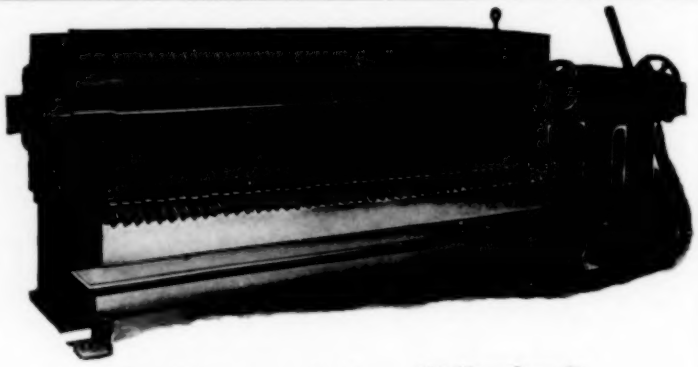

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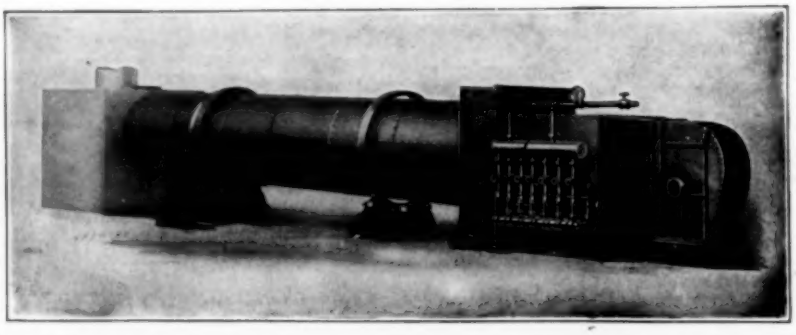

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Contents for October 15, 1917

EDITORIAL:
- The Chemist and the Banker 449
- Improvement in Tungsten Milling 450
- Alizarine 450
- Price Control of Iron Industry 451

READERS' VIEWS AND COMMENTS:
- Invention and the Flotation Suits. By Parker C. Choate 452
- Temperature Calibration of Glassware. By W. A. Wissler 452

The Western Metallurgical Field 453
Coming Meetings and Events 454
Société de Chimie Industrielle 454
St. Louis Meeting of the American Institute of Mining Engineers 455
Pittsburgh Meeting of the American Electrochemical Society. 458
Fractional Combustion. By Wilder D. Bancroft 470
Physico-Chemical Properties of Chrome-Nickel Steels. By Herbert J. French 473
Chemistry and the Banker. By Arthur D. Little and G. A. O'Reilly 476
Storage, Weathering and Spontaneous Combustion of Coal.. 481
The Treatment of Metallurgical Smoke in Japan. By Tetsurow Komakine 484
Radio-Activity and Some Advances in Physical Science. By Howard H. Barker 486
Hazards of Low Voltage Mill Machinery. By C. A. Lauffer.. 489
Sulphuric Acid in 1916 493
Synopsis of Recent Metallurgical and Chemical Literature.... 493
Recent Metallurgical and Chemical Patents 498
Electric Furnace Development at Sheffield, England 500
A New High-Frequency Induction Furnace 501
Increased Exportation of Crude Oil and Petroleum Products... 501
Temperature Indicator for Electrical Machines 502
An Interesting Flotation Process 502
Personal 502
Book Reviews 502
Current Market Reports—Non-Ferrous, Iron and Steel, Chemical Market and Chemical Price-List 504
Industrial—Financial, Construction and Operation and Manufacturers' Notes 508

The Chemist and the Banker

The war is developing and emphasizing the importance in this country of new industrial relationships. It is showing the interdependence of apparently unrelated elements of business, and acquainting professional and commercial strangers with each other and with their common responsibility to the country. It is pointing out the fallacy of successful independent existence and teaching the moral of co-operative effort. It is resulting in a getting together for common as well as individual good, and the creation of an unwonted habit of familiarity where formerly only a bowing acquaintance existed. A variety of examples might be cited to prove the truth of these assertions, but for our purpose it is sufficient to record the fact that the chemist and the banker have met on the common ground of mutual appreciation of the importance of each in the scheme of industrial affairs.

With a background of the National Exposition of Chemical Industries, in Grand Central Palace, New York, able representatives of chemistry and banking addressed themselves to the problem of initiating a closer relationship between chemical industry and finance. The chemist stated his need of the banker, and the latter evidenced his appreciation of the importance of the former. The banker was brought to the scene of the chemist's triumph and acquitted himself with credit. Had the tables been reversed, or should they be reversed on a future occasion, we feel that the chemist would give equally good account of himself in a gathering of bankers.

The symposium came as a proper climax to a series of technical meetings held during the exposition. It had a tremendous human interest because of its bearing on our national life and growth. The chemist forsook his laboratory, which to the banker is probably only a smelly place where things are done mysteriously, and the banker left his counting house which probably is an awesome institution to many chemists. They spoke a common language devoid of technical terms and got together on the basis of practical business. The banker saw chemistry as a factor in commerce and industry and the chemist got a view of banking as a helpful agent in developing business.

We have considered these addresses of sufficient import to the nation's business to publish them in full on another page in this issue. They will prove helpful and inspiring reading to industrial chemists, and should give bankers a new view of a relationship which many of them have not cultivated. Since bankers as a class are not likely to read the articles unless called to their attention, chemists owe it as a duty to themselves and the industry to see that the proper occasion

is created for their bankers' edification. What industrial and engineering chemistry has done in this country is slight compared with the possibilities already appreciated by leaders in the profession. The demand is for an equally keen appreciation on behalf of that other factor which has yet to realize that chemistry will prove as much to his future advantage as trade and commerce have in the past.

Improvement in Tungsten Milling

In view of the importance of tungsten in modern metallurgy it is a satisfaction to record the reports reaching us regarding recent improvements in recovering tungsten mineral from the original ores. This is with special reference to Boulder county, Colorado, which, as is well known, is one of the important tungsten-producing regions of this country and of the world. In order that the situation may be fully appreciated, the development of the tungsten industry in Colorado must be considered from the time when an unknown, troublesome, black, heavy mineral bothered the early gold miners of that region. It was as unwelcome there as was the carbonate of lead to the pioneers of Leadville, but likewise it later became the basis of a flourishing industry.

Quite naturally those who took early advantage of the demand for tungsten were the one-time gold miners and millers of that region. Equally as a matter of course, these men applied their gold-milling equipment to the concentration of tungsten ores. Stamps and bumping tables had been standard equipment for gold milling, and these devices in modern form were applied to the new problem. Slime recovery had been fairly well accomplished with stationary canvas tables, and these were added when it was found that tungsten minerals slimed badly in the stamps. Thus a practice was established without due regard to the new conditions, and the results were not the best. Early ideas proved tenacious, however, and in some new mills built within the past decade, stamps, tables and canvas plant comprised the means of grinding and dressing the ore.

Engineers then began to point out the futility of grinding a friable mineral to slime in a stamp mortar and attempting to make a satisfactory recovery on canvas. They showed that the ores comprised a hard gangue and a soft, heavy mineral, and that the latter remained in the mortar until it was pulverized. In this condition it was subject to heavy losses on any form of concentrating table.

The logical remedy suggested was roll-crushing and jigging; but jigs were more or less of an unknown quantity and a decided innovation. The suggestion was not welcome at first, but latterly it has been adopted and we are informed that the last stronghold of the stamp has fallen and that roll-crushing is now standard practice. In combination with jigging, which also has been generally adopted, roll-crushing avoids initial fine grinding and permits early recovery of the mineral in coarse form. The resulting improvement is true conservation of the metal.

Alizarine

Two young Jack Tars in U. S. Navy uniforms halted at the booth of a chemical engineering corporation at the Exposition in the Grand Central Palace. They conjugated their verbs properly; they did not say "subsidery" for subsidiary or sharpen the letter *s* beyond the custom of good English; in short their speech bore that quality of grace which classicists claim is best obtained by the study of the humanities.

"Sir," said one of the pair to the man in the booth, "when may we have uniforms dyed with fast colors? We are about to desert unless these be shortly forthcoming."

The man in the booth was raised Presbyterian and was accustomed to hear sermons preached. He also knew his Boswell. "Oh, my young friends," he responded, "do not do that evil thing. In yonder booth" (pointing to the du Pont exhibit) "they are already taking orders for indigo and there" (pointing to the National Aniline display) "they are accepting commitments for delivery next year. I am assured that real alizarine reds and blues, made from anthracene, will soon be produced and then you shall have no more trouble on this score. Let me urge upon you as you value the honor of our common country," etc., etc.

"Thank you, kind sir," answered the second, "we are now resolved to observe your admonitions and to follow your advice. You have saved us from the sin of desertion," etc., etc. The little party continued to amuse itself for five minutes or more in XVIII century fashion. But the man in the booth did not tell them how often he had been assured about alizarine colors, nor did he say that no preparations to make them appear to be in sight as yet.

American manufacturers of synthetic dyestuffs have done wonders in meeting the demands of the textile industry. By Jan. 1 we are informed that a good cotton vat blue, something of the indanthrene type, will be offered for sale and from that to the other fast cotton colors is but a short step. The yellows and reds and greens will soon follow. One American company is already making a ton of 20 per cent indigo paste a day and it makes also dibromindigo, which is an improvement. The products needed to avoid the unhappy substitutions now practised by dyers—by force of circumstances alone—are coming upon the market, one after another as the months go by, always excepting the real alizarine colors. Para red (from paranitraniline) is called Turkey Red and the way fabrics dyed with it smear things up is a matter of despair. American-made colors will not get over their reputation for instability until we have these splendid standard alizarine dyestuffs in plenty.

There is abundance of anthracene at hand and as much more will be produced as is desired; the oxidizing chromates are available, the talent to produce is here—in short everything is to be had except the plant. The equipment required to make alizarine is considerable and expensive but the undertaking is not as serious as that to make indigo. Of course, development has been

held back by the trick of Congressman Claude Kitchin of North Carolina who juggled the specific duty off of alizarine products in the Hill bill. The Honorable Claude can now have the satisfaction of looking at the dirty necks of Uncle Sam's Jackies and saying "I did it," for it goes without saying that if the specific duty had been allowed to remain on alizarine products as originally provided in the bill, these products would have been on the market to-day.

The colors could be made and sold now at a profit. What Congress will do when the war is over remains to be seen. We may, according to the men we elect, get a lot of reactionaries there who will want to throw down the bars and let foreigners dump dyestuffs and other products into the United States to their hearts' content and break up the whole industry here. The point is that there is an intense crying need for alizarine in this country now; we mean real, genuine alizarine; and if it can be made and sold at a profit—and it can—this should be done in spite of an individual Congressman.

Price Control of Iron Industry

Price-fixing in the iron and steel industry, inaugurated as to Lake Superior iron ore, steel bars, shapes and plates and certain descriptions of pig iron by the official announcement at Washington on Sept. 24, and being extended to practically all commodities in the industry, has been accepted by substantially all producers as a satisfactory remedy for the very undesirable market situation that existed. Buyers of steel, in the main, are well satisfied, but a few, lacking vision or mental equipose, have suggested as an objection to price-fixing that they find themselves unable to buy at the new prices. That, however, shows one great need for price fixing, since if producers are unwilling to sell at the fixed prices, an open market would expose the individual buyer to the evils of competitive bidding.

One cannot help wondering whether the satisfaction the iron and steel industry expresses over the arrangement that has been concluded has any connection with its oft expressed desire that it should be allowed to control its market, preventing prices from going too high in times of excessive demand and from going too low in times of inadequate demand. Perhaps it is thought that the experiment will work so well that the Government will be disposed to continue the practice after the war.

There is no reason at this time to assume that the Government will be so disposed. The Government has subscribed to no new principle, adopted no new doctrine. It simply explains a definition already adopted, regarding competition. The Sherman law, for instance, was enacted to preserve competition. Now all that is necessary is to explain that competition between sellers was meant, and it was competition between buyers that dictated the resort to Government price-fixing.

Nevertheless it is permissible to look upon iron and steel price-fixing as something which, while adopted purely as a war measure, may give such a good account of itself as eventually to suggest the desirability of its being continued, in one modified form or another, when peace returns. That would be natural, and altogether in line with many other things. Countless inventions, mechanical and chemical, have been forced by the stress of war, and no one would think of forgetting them after the war.

It must be recognized that price-fixing is not the only procedure in the Government's dealings with the iron and steel industry. In one respect it is only a subsidiary act. The Government requires that all the steel the industry can make that can be used by itself or its Allies must be produced before anything else is thought of. It is highly desirable that such operations of the people as conduce directly or indirectly to the prosecution of the war, such as the raising and transporting of crops, be facilitated by being supplied with steel as next in order, and that last in order be such supplies of steel as have no connection whatever with the immediate prosecution of the war.

To accomplish this end the Priority Board was recently constituted, to determine the order in which steel and other commodities shall be produced and shipped. To facilitate this work a schedule of prices is adopted, to apply upon all purchases. Thus it will not be materially more profitable for a mill to fill one order than another. In this respect price-fixing is subsidiary to the priority regulation.

It is very generally admitted that the price basis adopted is entirely fair to the iron and steel producing industry. Well it may be, considering the comparison the basis prices make with the average market during the ten years prior to 1914. These prices exceed the ten-year averages by the following amounts: Pig iron, 110 per cent; steel bars, 106 per cent; shapes, 99 per cent; plates, 117 per cent. If such prices were not high enough to produce large profits, resulting in heavy war taxes, it would be imperative to attack the cost of production from whatever angle necessary.

The Government is not done when it has established fixed prices and the priority shipment system. The priority system merely provides a sequence in which orders shall be filled. It does not in itself control or stimulate the production of any given material. That is more or less implied, but in the final working out the Government will undoubtedly be found to be going much farther than merely establishing the sequence in which orders shall be filled.

When the Government has finished decreeing what shall be done for it, there remain some obligations on its part. The dealings began by a mutual agreement, the authorities having power through legislative enactment to fix prices the Government shall pay for material it buys, while the producers conceded that they would charge the same prices to the Government's Allies and to the general public. In an open market, a shortage of steel results in higher prices, and if the ouput is less than the capacity, there is a compensation in higher profits per ton for the fact that the number of tons is less. With a fixed price there is no such compensation, and the Government should employ all the resources at its command to stimulate the production.

Readers' Views and Comments

Invention and the Flotation Suits

To the Editor of Metallurgical & Chemical Engineering

SIR:—We now have heard many decisions of our courts, practically all sustaining the theory and practice broadly of the patents of Sulman, Picard & Ballot owned by the Minerals Separation Company.

We read many opinions of corporation engineers, and editorial commentators, to the effect that the courts are mistaken.

It appears wrong that business interests should control and exploit purely for mercenary gain valuable basic patents, but no more wrong than that industry should seize a basic inventive thought and practice and make fabulous wealth, and decline to share with research. We hear nothing about the inventor or community benefit or the purpose of patent law or that the patent laws are wrong, or should not exist. For more than a generation our patent laws have been kicked about like footballs, the force of money being used to defeat the equity of invention. Only through exploitation by capital interests can an invention be defended and become an asset to the owner.

It is just possible that the law of action and reaction is about to assert itself, and an equity balance is to be established by broad legal rulings. If this is so the results of research will become assets with recognized rights, and not mere chattels, which the inventor cannot use for the benefit of himself or his ideal, research, and the best public utility.

To say that there is no invention in the art of flotation as disclosed by the research of one of Sulman, Picard & Ballot, would be to deny one of the greatest metallurgical industrial advances of the generation. There was no practical art previously with no community benefit.

It is true that corporation engineers have adopted and applied, and their employers reap the benefit.

The patent law says that the inventor shall have a monopoly protection for a period as incentive. He should be forced to permit public use, but always is more than desirous of such.

A royalty should be paid him as the only good solution of business relations in common commodity inventions.

Somebody or mind must set the ball in motion, and such person is the inventor as declared by the U. S. Patent laws. Others who have found the ball too heavy to start, and those who help just after motion, are not the creators of the motion, which is the analogy used for invention. If the community wish some different form, the patent laws must be changed. Whether the profits are justly or unjustly distributed is no part of the courts in deciding patent standings, they are called up to decide in marked cases like the flotation art, as to what was the cause of industrial motion, which gave community benefit.

The inventions of S., P. & B. stand out prominently and must be considered basic after a Supreme Court decision. If there is now invented a decided advance it must have individual rights, but so far we see only acknowledged evasions based on literal readings of decisions attempting only to define results by means of a degree, or we see other means creditable and patentable in themselves being advanced as displacements of the original conception, but producing largely the same result.

Who is there among the engineers and editors who condemn our courts, who will show where industry will ever make any equitable proposition to an inventor recognizing his asset?

If industry would deal direct with research or through some clearing house, and not attempt to clip the wings before and after the act, few inventors would be forced to assign to capital or industry in order to get the small share they may receive; litigation would largely cease, because patents would not be used as financial clubs, and the community would be better served, because the common suppression of invention for business reasons would largely be prevented.

The inventor or his affiliated interests are usually the safest custodians in whom titles can be rested, and much more usually do they apply any increment to further research desired by community, and are best able so to serve. Analysis would seem to show that industrial greed or money power is the monster, not the courts, patent law or the inventor.

It is highly desirable for industry to meet Minerals Separation in some proper way to stop such useless litigation; but like the world war, if a lesson can be learned so to organize as to prevent future waste and serve community interests, the struggle will not have been in vain. Kings and oligarchies can never rule an enlightened people properly, any more than industry or capital interests can control research without great friction and waste. Research and invention is the light, the advance; it cannot be led, pushed or forced, it must find the way and be free to do so.

PARKER C. CHOATE.

Essex, Mass.

Temperature Calibration of Glassware

To the Editor of Metallurgical & Chemical Engineering

SIR:—It is often necessary to make up solutions of standard volume when water of the desired temperature is not available. Some of the work encountered in commercial laboratories requires that the solution be made up to a definite volume, so that aliquot portions may be removed. If these portions are all taken at the same temperature as that at which the solution was diluted to its volume, there is no resulting error. However it is sometimes necessary to take the samples at different times, and if the solution changes in temperature between these samplings, an appreciable error will be introduced. At other times it is desired to make standard solutions from weighed amounts of materials, and in order to secure an accurately made solution it is necessary to allow the solution to come to the standard temperature before filling the flask to the mark.

It was found that volumetric apparatus may be calibrated with respect to temperature. For example, a liter

flask may be marked with its original calibration at 20 deg. C, and in addition may be marked to show the volume that that amount of water would have at temperatures from 15 to 35 deg. C. Pipettes may be treated in the same way, and with such apparatus the above errors may be eliminated. If the water at hand has a temperature of 31 deg. C, the flask should be filled to the corresponding mark. At any time thereafter, true aliquot portions may be withdrawn by the pipette, by simply noting the temperature at which the sample is taken, and filling the pipette to that mark.

The methods of standardizing at different temperatures are exactly similar to methods used at any standard temperature. For approximate work, the flask may be filled under its standard conditions, stoppered, and heated or cooled through the temperature range desired, suitable markings being made at regular temperature intervals.

The use of such apparatus results in eliminating either the waste of time of securing water of standard temperature, or the errors caused by using water at indefinite temperatures.

W. A. WISSLER.
Cambridge, Mass.

Western Metallurgical Field

Electrometallurgy in the Northwest

Considerable attention is being devoted to the prospect for electro-metallurgical development in the Northwest. At the present abnormally high prices for electro-metallurgical products, the time is most opportune for launching ventures which promise even moderate success. Of course, the first cost of plant now would be high, but at the present extremely high prices for the product, a really good development should be able to write off this first cost within a few months. Furthermore, plants started now should be able to pass through the experimental and adjustment stage in a time when the highest economy and efficiency of process is not vital to financial success.

These conditions, however, have drawn into the field a number of companies, for the most part still in the promotion stage, whose chief purpose seems to be a short cut to the profits. Such ventures are usually not attended with development along permanent lines. Almost any plant and an inefficient process make money now, but when prices come down again the plants which were hastily planned without competent supervision will not be able to continue and their failure will reflect harmfully upon the industry.

It is, therefore, well that new ventures in this field, even in the present favorable times, should be launched only upon the advice of competent experts. The questions which are given first importance now in the Northwest are: (1) Is there enough raw material to warrant the development of a permanent plant? (2) Can it be reduced so as to make a profit at post-war prices? and (3) Considering the development on a permanent basis, what equipment should be installed and how shall the process be developed so that the greatest financial returns shall ultimately accrue?

It is interesting to note that in the Puget Sound region, eight electric furnaces for the reduction of steel scrap have recently been put in operation, two of these are three-ton capacity and the others are smaller. Two other plants, to be built somewhat along the same lines, are under construction and still others are contemplated. One company in Portland, Ore., is using the electro-metallurgical process for ore reduction and is now producing ferro-manganese.

Important Litigation in the Coeur D'Alenes

The American Smelting & Refining Co. has filed suit in the Federal Court at Portland, Ore., against the Bunker Hill & Sullivan Mining & Concentrating Co. of Idaho, asking that the defendant be enjoined from operating its recently constructed lead smelter at Kellogg, Idaho, and be compelled to fulfill a contract entered into with the plaintiff for the sale of lead ore and concentrates. The complaint reviews the relations between the two concerns with regard to a 25-year contract made in 1905, wherein Bunker Hill agreed to sell to the plaintiff's Tacoma Smelting Co. all the output of its mine carrying from 30 per cent to 75 per cent lead. For this product the plaintiff was to pay for 90 per cent of the lead content and 95 per cent of the silver, and the contract was to be subject to revision at five-year intervals. It appears that at the second revision period, in 1915, Bunker Hill made a demand for more favorable rates, which were refused, whereupon it proceeded to erect its own smelter at Kellogg for the reduction and refining of its output. This plant was put in operation about July 15, 1917. Plaintiff now seeks to enjoin Bunker Hill from operating the plant, and asks an order compelling specific performance of contract.

Chloridizing Flotation Concentrates at the Buffalo Mill, Cobalt

The Buffalo Mines, Ltd., Cobalt, Ontario, Canada, was the first company in that district to adopt and operate the flotation process on mill tailings. The Callow pneumatic system was adopted, and after due experimentation a 600-ton plant was built for the treatment of the daily mill production of 150 tons, together with 450 tons of old tailings. According to the annual report of Arthur A. Cole on the mining industry of northern Ontario, the plant is simple, consisting of tube mills in closed circuit with Dorr classifiers, four two-compartment triple-length Callow cells for roughing, and four two-compartment cells for cleaning the rougher product.

The cleaner cells make two products, a concentrate which is sent to the "high-grade" mill, and a tailing which is treated in the "low-grade" cyanide plant. The treatment of the concentrate is an interesting departure from methods hitherto used in the Cobalt district, and consists in a combination of chloridizing-roasting and cyaniding. The concentrate first is treated with 30 lb. of lime per ton, thickened in a Dorr thickener and filtered on an Oliver filter. Salt is added, partly as a brine wash and partly as solid. The concentrate is then dried, and, after further addition of salt and sulphur, is roasted. The roaster first used was a reverberatory, but it is reported that a Holt-Dern shaft roaster, of the type developed and used in chloridizing Utah ores, is to replace the reverberatory. The roaster product is given a wash with a 13 per cent hydrochloric acid solution and passed over scrap iron for precipitation of copper. The pulp is washed and agitated with a 15-lb. cyanide solution

in which silver chloride dissolves rapidly. The pregnant silver solution is precipitated by sodium sulphide, and the precipitate is refined in an oil-fired reverberatory furnace.

Substitutes for Platinum

The importance of platinum in chemical and metallurgical work, and the prevailing high prices for the metal, have led to investigations for successful substitutes. Two such products, alloys of gold and palladium, have been placed on the market in various forms for laboratory use, and have been receiving the close attention of chemists. As far as can be ascertained at the present time, the new alloys are giving satisfaction in many lines of work, notably in smelter and metallurgical laboratories, in the form of dishes for evaporations and fusions, and as cathodes for electrolytic analysis. When used with reagents other than boiling concentrated nitric acid, alloys of appropriate composition may be chosen to give service equal to or better than that of platinum. This is especially true in the case of boiling concentrated sulphuric acid.

In appearance the alloys are practically white, and it is with difficulty that they can be distinguished from platinum. This fact has opened the way for deception in disposing of supposed scrap platinum, and for this reason some companies have temporarily discontinued buying the latter material or making allowance for it on new ware.

An item of importance in the substitution of these new alloys for platinum is their lower cost. With large companies operating a number of laboratories, this becomes a consideration, for at present prices the platinum equipment can be disposed of at an appreciable profit. Another factor is that there is less probability of theft of the cheaper alloys than of the expensive platinum. While thefts of platinum are not heralded abroad, they have amounted to a considerable sum in schools and laboratories in the last year or two.

Coming Meetings and Events

American Electrochemical Society, autumn meeting, Pittsburgh, Oct. 3-6, 1917.

American Institute of Mining Engineers, annual meeting, St. Louis, Oct. 8-13, 1917.

American Gas Institute, Washington, D. C., Oct. 16-19, 1917.

American Society of Mechanical Engineers, New York, Dec. 26-29, 1917.

Plans Discussed for Next Chemical Exposition

The Advisory Board of the Chemical Exposition held a meeting at the Chemists' Club on Sept. 29, at which plans were discussed for next year. It was an enthusiastic and inspiring meeting and great satisfaction was expressed with the wonderful exposition held this year. Several improvements for next year were discussed, resulting from the experiences gained this year. Those present were C. H. Herty, chairman; M. C. Whitaker, H. B. Faber, A. D. Little, R. P. Perry, L. H. Baekeland, F. W. Payne, C. G. Fink, B. C. Hesse, G. W. Thompson and C. F. Roth.

Société de Chimie Industrielle

A society of Chemical industry has been formed in France and will be known as the Société de Chimie Industrielle. Lieut. René Engel, a member of the French Scientific Mission to the United States, is secretary of the society. He, together with Professor Grignard of Nancy, were interested guests at the Boston meeting of the American Chemical Society and the Chemical Exposition.

Through Lieut. Engel's efforts the French Society and the needs of chemistry in France have been brought before several representative American chemists, and Dr. Jerome Alexander, with the co-operation of many representative American chemists and manufacturers, has started a movement to form an American section to the French Society. He points out that it is not a question of needing more chemical societies in this country, but that France needs our moral support in order that chemistry may play a more important part in the nation. We should not hesitate to lend this helping hand when it is so badly needed.

A circular has been formulated and will be sent to the chemists and manufacturers in this country. The first part of this circular follows. The letter of the president and the abstract of by-laws are not included here but will be included in the circular:

To the Chemists and Manufacturers of America:

There has been formed in France a French Society of Chemical Industry, the Société de Chimie Industrielle, whose objects are fully set forth in the attached letter of Mr. Paul Kestner, President of the Society.

After consultation with Mr. René Engel, Secretary of the Society and a member of the French Scientific Mission in the United States, the undersigned committee believes that it would be most opportune to establish an American section of the SOCIÉTÉ de CHIMIE INDUSTRIELLE, and thus extend to our French fellow chemists and manufacturers our moral and financial support and the right hand of good fellowship.

Furthermore, members of the American section will benefit by the closer relations which will naturally develop between American and French Chemical Industry.

An abstract from the By-Laws of the French Society is hereto annexed, together with application for membership in the American section, which should be filled in and returned to the Committee:*

Jerome Alexander	Frank Hemingway
Leo H. Baekeland	Elwood Hendrick
Raymond F. Bacon	Charles Herty
Wilder D. Bancroft	J. B. F. Herreshoff
Charles Baskerville	George F. Kunz
Albert Blum	Parker C. McIlhiney
Henri Blum	William H. Nichols
Marston T. Bogert	Charles L. Parsons
M. Cérésole	Charles L. Reese
Arthur M. Comey	Allan Rogers
Charles A. Doremus	Samuel P. Sadtler
John V. N. Dorr	Maxmilian Toch
William M. Grosvenor	Gustave W. Thompson

Christian B. Zabriskie

Information in regard to the American Section should be addressed to the Organization Committee of the American Section of the Société de Chimie Industrielle, care Chemists' Club, 50 East Forty-first Street, New York.

*These By-Laws and the President's letter are included in the circular.—Ed.

St. Louis Meeting of the American Institute of Mining Engineers

The war-time convention of the American Institute of Mining Engineers which opened at St. Louis, Oct. 8, was notable for its patriotic spirit and atmosphere as well as being the largest meeting in the history of the Institute. The meeting opened with a patriotic session which was presided over by President Philip N. Moore. Secretary Stoughton read the following letter from SIR R. A. HADFIELD, honorary member:

"Just a few lines to say that a magnificent reception was given to-day to your troops marching through London. God bless America. To-day has been epoch-making in the history of the Anglo-Saxon race. Whilst we English may not show our emotions as freely as others, America's activity in the course of the war and the splendid way she makes preparations touched deeply the hearts of my countrymen and all of us."

This was followed by a message from HERBERT C. HOOVER:

"Urge upon members that they preach and practice the gospel of saving, service and sacrifice. This must be brought home to every citizen if we are to emerge from this cataclysm a unified free people. Government indebtedness can only be paid from savings. We must make whatever sacrifice necessary whether in our own personal expenditures or as volunteers in national service or supreme sacrifice as soldiers in trenches to make the world safe for democracy. We must all save, serve and sacrifice."

HENRY M. AMI in bringing greetings from the British Legation and the War Mission said that the fact that the United States had entered the war was the greatest asset of the allies. He called France, Great Britain and the United States the world's granite nations, most durable and strongest. Carrying out the simile he likened the French to mica, polished and smooth, the British to quartz, with its grit and durability and the United States to feldspar as a composite. Each of these is necessary and useful to the formation of a peace league that will endure forever.

LIEUTENANT COLONEL DEBILLY of the French Commission showed how France and Russia were forced into the war by invasion, England to protect Belgium and America as a result of ruthless submarine warfare. All are fighting for independence. Various past wars have emphasized different needs. The Boer war showed the importance of shelter, and the Manchurian war of munitions. The present is a war of engineers and therefore we find them enlisted in making roads, trenches, saps, mines and communications and in industry producing raw materials and munitions. He stated that trench life was one of democratic discipline and was not antagonistic to friendly fellowship. Officer casualties have resulted in 80,000 merit promotions from the ranks. Speaking of the tremendous future work of rehabilitating the invaded districts of Belgium and France he felt confident of America's ungrudging help.

FEDOR FOSS of the Russian Commission said that at the outbreak of the war the offer of aid from scientists and engineers was refused by the Russian beaurocracy. After eight months' negotiations, however, when lack of munitions on the Galician front brought disaster and retreat, the organization of public war industrial committees was allowed, in which all intelligent forces were needed for the production of materials and munitions. The old Government was suspicious and obstructive, as indicated by orders recently found cancelling steel shipments to co-operating concerns. America's help has been invaluable, since three-fourths of the necessary machinery has come from this country. Russia has also commenced the mining of tungsten, and the smelting of zinc, lead and mercury. It has also tripled the production of sulphuric acid and has expanded the platinum industry. The mobilization of 15,000,000 soldiers has deprived Russian industry of its best men and a shortage in raw material has been averted only by strenuous effort. But the army has now all prime necessities, and following the temporary demoralization due to the revolution and the subsequent elimination of internal enemies, the success of the Government seems certain.

F. W. DEWOLF reviewed the organization of American civilian committees and boards, and showed rapid evolution and real progress in spite of mistakes, jealousy and misinformation. In his opinion final victory would come not to a temporarily perfect war machine but to the nations receiving the spontaneous effort of all citizens.

Chairman WESTERVELT of the War Minerals Committee reviewed the work of that organization and stated that there was an urgent call for sulphuric acid makers to use pyrrhotite and marcasite in place of pyrite. Those who can or will use the first mentioned minerals are requested to forward their names to the American Institute of Mining Engineers, New York, or U. S. Geological Survey, or Bureau of Mines, Washington, D. C.

DAVID WHITE of the Geological Survey related recent activities in mapping, investigating and reporting the mineral production of the United States. He stated that picked drafted men has been detailed as topographers to fill the ranks of the Survey. A. G. WHITE of the Bureau of Mines, and Secretary of the War Minerals Committee, described in detail the activities of the organization and explained that present efforts were directed only toward the most obvious necessities.

W. O. HOTCHKISS electrified the assembly by stating that it was imperative that each should realize that "this is my war." We are fighting an enemy who knows his resources minutely, whose Government organization, scientific activity and industrial expansions have been created and controlled to wage a successful and terrible war. We are scattered and are approaching a crisis unprepared and unarmed. Everyone should ask "Am I doing my share?" and should do anything he sees to do without waiting for instruction. We should also ask, "Is the Government doing all that it can?" and then see that it does.

Session on Milling

The Hancock Jig in the Concentration of Lead Ores was presented by HAROLD RABLING, of St. Joseph Lead Company. His notes were based on a standard 25-ft. Hancock jig tested in regular operation in the Bonne Terre mill of the St. Joseph Lead Company. The reason for the investigation was the crowding of the circuit due to the return of re-crushed middlings. The tonnage in circuit grew to such enormous proportions that it became imperative to either decrease the amount of middlings or provide more crushing capacity. Investigation was accordingly made of the jigs, including speed, length of vertical and horizontal strokes, depth of bed, size of grains forming the bed, and specific gravity of those grains. As a result of the study, more efficient jigging was done and the tonnage was raised from 1800 to 2200 tons per day without increasing jig equipment.

Discussion of this paper brought out the fact that jigs throughout the district receive three-quarters of the total original feed, the balance going to tables and flotation apparatus. Jig losses are from three to four times those from tables. The circulating load may build up to a point where it equals the original feed.

Concentration Practice in Southeast Missouri was thoroughly covered in an elaborate paper by Mr. A. P. WATT, giving data on crushing, grinding, screening, jigging, classification, tabling and flotation.

The concentration problem of the district is to save the galena and discard the other metallic minerals. The concentrate must be as clean as possible, not only to save smelting charges, but also to permit the smelters to handle efficiently the concentrate, particularly if the Scotch hearth be used. The galena should be recovered in a size as large as possible.

Hand-picking is not generally practised but is advisable to some extent in order to prevent large quantities of gangue from wearing the mills unduly. In the field of crushing the usual practice is to use gyratories as primary machines, followed by Symons crushers or rolls. There is nothing of special interest about roll practice in the district.

In classification and tabling, the introduction of the Butchart table has done much to simplify practice. Classifiers generally have been eliminated and replaced by apparatus for desliming only. The problem of table treatment is simplified due to the difference in the sp. gr. of galena (7.4) and dolomite (2.85).

Considering the subject of regrinding machines, the author considers the Marathon to have advantages over ball mills. The line contact between the rods gives positive crushing, and the use of rods instead of balls permits use of less power for equal weight of crushing metal. Steel consumption is less and the wear on the liner negligible. The rods must be removed when worn, otherwise they are likely to bind into bundles or coil like springs. Rods wear more rapidly at the discharge end of the mill.

Present methods of slime treatment include both gravity processes and flotation. Numerous types of flotation machines are used in the district. The flotation concentrate is filtered, yielding a cake containing about 14 per cent moisture, which must be dried. The problem of drying has been satisfactorily solved by the Lowden dryer. Since the cost of flotation is many times that of tabling, and the flotation concentrate lower grade than table concentrate, every effort should be made to minimize the tonnage treated by flotation.

The Milling Practice of the St. Joseph Lead Co., by L. A. DELANO was printed in our issue for Sept. 15. To the information therein contained, Mr. Delano added some data on the Allen cone. The coarsest concentrate handled is through 9 mm., with a complete range of sizes; the coarsest sand through 2 mm. A 4-ft. cone handled 145 tons per day, with an overflow containing 97 per cent of solids minus 200-mesh. The spigot product carried 30 per cent water and 5 per cent solids minus 200.

Ore Dressing Practice in the Joplin District, by C. A. WRIGHT, of the U. S. Bureau of Mines, contained a condensed statement of the author's study over a period of several years. The paper was praised as being the first adequate presentation of conditions in the district. The general practice at Joplin results from small ore bodies and short leases, and fits conditions very well. Some of the data embodied in Mr. Wright's study were published in this journal, Sept. 15, 1916.

Tuesday Sessions

The program for Tuesday, Oct. 9, included a morning session on lead, a boat trip to Herculaneum to visit the smelter of the St. Joseph Lead Co., and an evening session on miscellaneous subjects.

The rôle of **Salt in the Metallurgy of Lead,** as presented by Messrs. O. C. RALSTON, C. E. WILLIAMS, M. J. UDY and G. J. HOLT, has already appeared in abstract in our issue of Oct. 1. Discussing the volatilization process for oxidized silicious lead ores, Mr. E. L. BLOSSOM stated that laboratory tests had yielded an extraction of over 90 per cent in one hour, but that a reverberatory treatment required eight hours, and yielded only 75 per cent extraction. The White revolving kiln increased the speed of reaction, but lack of ventilation builds up a vapor pressure in the interstices of the ore, damping volatilization. The blast-roast may afford a solution of this problem.

C. L. LARSON questioned some of the chemical statements in the author's paper, on the basis of extensive successful work at the Bunker Hill property in Idaho. Details of this will be published later.

ARTHUR THACHER referred to the early days of leaching processes, such as the Ziervogel, in which the delicate roasting of silver ore preceding hyposulphite leaching was successfully conducted, with a resulting extraction of better than 90 per cent. He thought that physico-chemical investigations were needed, and suggested that the Stedefelt shaft furnace would be useful in this work, giving a short contact under favorable conditions.

The Metallurgy of Lead Ores in the Lower Mississippi Valley, by HERMAN GARLICHS, presented at this session, has already been published in abstract in our issue of Aug. 1. The trip of the Institute to Herculaneum afforded opportunity to see the practice described.

Increasing Dividends Through Personnel Work is the title of a paper by THOMAS T. READ, in which he outlined the nature and necessity of more attention to human engineering in industry. He defined his field as follows:

Personnel work is a term recently introduced to cover the great variety of activities in industrial work

that deal with the human factor. Much attention has been focused upon individual phases of personnel work, such as accident prevention, sanitation, "welfare" work, reducing labor turnover, and so on. In most cases these activities have been carried on as though they were distinct and separate fields; as a matter of fact, they are only different phases of the single problem of human engineering, and each has important and fundamental relations with the others. Thus, for example, high labor turnover is one of the most important causes of a high accident rate, and unsatisfactory housing conditions are an important cause of labor turnover. In the early stages of the study of these problems it was necessary to take them up separately; the time has now arrived at which it is desirable to consider them as a whole, in order to bring them into the right relation to each other. When thus considered as phases of an interrelated whole, they may be grouped as personnel work.

As a result of his study of the problems involved in this work, the author reaches the following conclusions:

Labor has become the largest cost factor in productive industry, and seems likely to continue its relative increase. The ideal of industry is a laborer who is sober, efficient and steady. The first is in progress of attainment by the advance of prohibition of the liquor traffic. Efficiency in the workman is attained through better management and training of the worker. Lost time is overcome by the prevention of accidents and illness, and through a great variety of means that bear indirectly, as indicated above, on the labor supply. Industrial accident prevention looms large in the public eye through the recent enactment of compensation laws, but as a source of lost time to the plant and lost wage to the worker it is much less important than illness. Health insurance is now being urged in many quarters, and if it comes about we may expect a transfer of emphasis from accident to illness prevention. Lost time through religious holidays and other personal activities, or inactivities, of the worker, is much more important than either; their relative values being something like 1, 4 and 10 in most cases. The only practicable means of dealing with the latter seems to be the offering of a bonus, over and above wages, to the workmen who lose no time each month. The underlying purpose of personnel work is to conserve the labor supply and decrease the net cost of productive labor. Personnel work is human engineering; it requires natural aptitude and special study, and is not a field for the well-meaning amateur, especially the amateur who is unfamiliar with the peculiar problems of the industry in question.

In discussion, Mr. CHARLES W. GOODALE of the Anaconda Copper Mining Co. criticised the central employment bureau advocated by the author, and pointed out the destruction of discipline through the process of "hiring and firing." With reference to the "rustling card" system, he stated that of 53,000 cards issued by his company only 650 had been refused.

The History and Legal Phases of the Smoke Problem, presented by LIGON JOHNSON, traces the early history of the smelter-fume problem and the development of the more acute controversies in recent years. The early prejudice engendered by the practice of heap roasting is considered responsible for much of the modern antagonistic attitude of the farmer toward the smelter. The institution of suits by the farmers necessitated elaborate scientific investigations by the smelters to determine the extent and magnitude of damage by smoke and fume. This resulted in securing information that was of value, not only to the smelter but also to the farmer, from the point of view of scientific farming. This has resulted in a friendlier relation between farmer and smelter. The final trouble which still needs to be removed is the idea of the farmer that visible fume is dangerous, and that the gases must be entirely cleared of solids. This is a psychological matter, which will require education to rid the farmer of his belief.

Discussion by P. J. O'GARA, technical director of smoke investigations for the Guggenheim interests, brought out the fact that efforts to obtain visible clearance of the smoke would be futile, since the solids are mainly harmless. The problem can be solved by clearing solids only for recovery of valuable material, and keeping sulphur dioxide below the critical concentration when the humidity is over 70 and the temperature over 40. This can be done even if it requires the temporary shutdown of roasters. It is better to install high chimneys, as at Tacoma, or gas absorbers. Farming experiments show that the lowest gas concentrations more than double the leguminous produce on alkali lands, freeing potash and phosphorus and lessening the soluble alkali.

ALBERT H. FAY of the U. S. Bureau of Mines described the preparedness census of mining engineers, metallurgists and chemists taken by the bureau in co-operation with the American Institute of Mining Engineers and the American Chemical Society. The bureau has a complete list of technically trained men who have been mobilized by the draft, and is in daily conference with the War Department in attempts to transfer these to technical service where they will be of greatest value to the Government.

MR. ALFRED WILSON of the Canadian Department of Mines urged upon this country the conservation of sulphur supplies. At present the Canadian consumption is 300 lb. per ton of sulphite pulp, whereas American is only 250. By educating competent burners, we may save a considerable quantity of sulphur. Further assistance can be rendered by burning pyrite scientifically and reducing the consumption of print paper.

Decrease in White Lead Output in 1916

The United States Geological Survey has completed the statistics of white lead production in 1916. The output of dry white lead was 32,938 short tons worth $4,714,343 as compared to 33,907 tons worth $3,513,856 in 1915. The production of white lead, which was ground in oil, was 96,041 tons worth $16,560,137 as against 122,194 tons worth $15,879,835 in the previous year. The total output of white lead thus showed a loss of 27,122 tons or over 17 per cent in quantity, but a gain of $1,880,789 or nearly 10 per cent in value. The annual report of one of the largest white lead producers says:

"The tonnage of white lead sold was the lowest in many years, due in part perhaps to the activity of competitors but chiefly to the checking of consumption by the high prices not only of white lead but of linseed oil and everything entering into the cost of painting, including wages."

Pittsburgh Meeting of the American Electrochemical Society

The thirty-second general meeting of the American Electrochemical Society held at Pittsburgh, Oct. 3 to 6 inclusive, was marked by the same interest and enthusiasm which is usually in evidence at the sessions of this organization. With a registration of over 325 members and guests the meetings were well attended. The program contained too many excellent papers to afford time for as much discussion as would have been profitable. On the other hand a large number and variety of inspection trips arranged by the local committee gave an opportunity for social and professional intercourse and enabled the visitor to get a comprehensive idea of Pittsburgh's varied industries. The visiting ladies were entertained at receptions, luncheons and dances, one of the features being an invitation luncheon at the Heinz plant, where the famous 57 varieties are made.

Members who were fortunate enough to be present on the first day were guests at the Oakmont Country Club, where golf was the order of the afternoon. In the evening an informal dinner was served at the club, which was attended by 100 members and ladies. Following this the Board of Directors held its regular meetings at which important business was transacted.

Meeting of the Board of Directors

It was voted to subscribe for $2,000 worth of the new issue of Liberty Bonds. The Society also made its customary appropriation of $50 to the International Committee on Physical and Chemical Constants, inasmuch as word was received that the Committee's volume will be issued this year in spite of the war. Dr. C. A. Doremus was appointed to serve with Jos. Bijur as the Society's representative on the War Committee of Technical Societies. While no definite decision was reached regarding the place of the next meeting it was the sentiment of the Board that a meeting in the South next spring would be timely and appropriate. No invitations have been received from this section and definite decision is deferred until a later date. The proposition of meeting at Cleveland was not acted upon at this time in view of the proposed Southern meeting.

Thursday Meeting

The opening session was presided over by President C. G. Fink, who introduced Dr. John A. Brashear of Pittsburgh, who gave an address of welcome. Dr. Brashear painted a panorama of Pittsburgh's scientific and engineering progress as he had personally observed it during more than half a century. He recalled his early association with many famous scientists and engineers, such as Langley and Westinghouse, and related many interesting anecdotes of the struggles and successes of these men.

Mr. Lawrence Addicks and Prof. J. W. Richards, who are the Society's representatives on the Naval Consulting Board, briefly reviewed the work of that organization. Mr. Addicks stated that real progress was being made in the submarine problem, and that there have been positive advances in the protection of merchant ships. Professor Richards announced that the Secretary of the Navy had decided to commission a few graduate electrical engineers as engineer officers in the Navy. These men must be between the ages of twenty-five and thirty-five and the salary will be about $2,300 per annum.

Electrochemical Industries at Shawinigan

The first Thursday paper was presented by **H. E. Randall,** electrochemical engineer of the Shawinigan Water & Power Company, Montreal, describing the development of electrochemical industries at Shawinigan, in the Province of Quebec, Canada, in the St. Maurice Valley, and its availability for further electrochemical plants. He pointed out that at present 511,000 hp. is installed, of which 100,600 hp. is available for immediate use. There is also 580,000 hp. as yet undeveloped which would also be available for electrochemical industries. The principal plants there at present belong to the following companies: Northern Aluminum Company (formerly Pittsburgh Reduction Company), Canada Carbide Company, Shawinigan Electro-Metals Company (magnesium), Canadian Electrode Company (carbon electrodes), Canadian Electro Products Company (acetic acid and acetone), Presto-O-Lite Company (acetylene), Fraser, Brace & Co. (experimental electric furnace work), Canadian Aloxite Company (subsidiary of Carborundum Company).

The author points out that with its low power costs, cheap labor and advantageous export rates it offers a strategic location for serving the European market. At the moment it is one of the few localities in Canada where power in quantity can be obtained quickly and cheaply, and where the necessary labor for plant operation can be obtained without excessive importation. With these present advantages and future possibilities the author thinks it almost certain that Shawinigan will continue to be the electrochemical center of the Dominion of Canada.

Substation Problem of the Electrochemical Plant

In a paper on this subject **J. L. McK. Yardley,** general engineer of the Westinghouse Electric & Manufacturing Company, discussed the relations between the electrical apparatus conditions and the electrochemical conditions; that is, between the factors conditioning efficiency or inefficiency of the electrical installation and the factors imposed by the nature of the electrochemical cells and their arrangement into plant units. The principal conditions which determine the substation layout and the nature of its equipment are given by the author as follows:

(1) The nature and magnitude of the process; that is, the amount of current required per unit cell, tank or pot room, the voltage range, the length of time; also the number of units and the ground space available.

(2) The nature of the power supply, particularly whether the voltage is high or moderate and whether it is practically constant or subject to variations.

(3) The inherent characteristics and costs of available apparatus.

Owing to the intense activity in all the electrochemical industries, such as zinc, copper, aluminium, chlorine and caustic soda, etc., during the past three years, a great variety of new propositions has come under consideration. In most cases it has been found necessary to give full consideration to each condition. An interesting extract from the paper follows:

"Such mistakes and failures as have occurred have only tended to show that in the future there should be still greater co-operation between those whose efforts are able to bring about still greater success. Let us make as sure as we desire of the credentials of the man who wishes to co-operate with us, and then let us co-operate, without stint.

"To take a very simple illustration of the sort of problem to be met, let us assume one desires to produce 20,000 lb. (9000 kg.) of caustic soda per day and has found that a total of approximately 252 electrolytic cells of a certain size are required. It is very doubtful that there are any good reasons from the process point of view why these cells should be arranged in three groups of approximately 84 in series in preference to four groups of approximately 63 in series; whereas, from the apparatus point of view there are good reasons in favor of the latter arrangement. Its requirements fall within the voltage range of apparatus which through years of use has become standardized the country over.

"The manufacturers of electrical apparatus are wide awake to the rapid growth in the electrochemical industries, and they are keen to be leaders in that growth by adapting and applying their apparatus to its requirements in the most economical way, and by anticipating its future wants in new designs. However, it seems just as logical that the others who are interested in this development and want to make it an economical one, *viz.*, the inventors and manufacturers of cells, pots or furnaces and those who arrange them, assemble them, build them into a complete plant, and operate them—should work with equal or even greater zeal for a size and arrangement having requirements which, as nearly as possible, can be met by already standardized electrical apparatus. When one considers the relative costs of the electrical apparatus installation and the cell or furnace room installation, it is quite obvious that this should be so."

Electric Furnaces in the Iron and Steel Industry

The paper by **Robert Turnbull,** electric furnace engineer of Welland, Ont., Canada, was an interesting discussion of **Electric Pig Iron in War Times.** It is reproduced here in full.

* * * *

The abnormal high prices which are at present being paid for iron and steel products, and which have been ruling for the last eighteen months, have seemingly failed to stimulate or encourage the manufacture of pig iron from ore in the electric furnace. Although from $50 to $80 per ton is now being paid for the different grades of pig iron, no progress has been made in the United States or Canada in the production of electric pig iron from ore, and it may safely be said that outside of Sweden and Norway the production of pig iron from ore in the electric furnace is practically *nil.* That pig iron could be made from ore in the electric furnace under present conditions, and at the same time yield a handsome profit, there is not the slightest doubt, but there are many difficulties in the way of the prospective manufacturer and one of the most serious is the shortage of power.

In the early part of 1906, when the smelting of pig iron in the electric furnace was undertaken by the Canadian Government, the report issued some time afterwards claimed that the results of the experiments had proved that 4 tons of pig iron could be produced per horsepower-year; in other words, this amount of iron could be produced with an expenditure of about 1650 kw.-hr., whereas the present Swedish practice, where large furnaces are used, shows that from 2500 to 3000 kw.-hr. is required to produce 1 gross ton of gray iron.

A few years ago the writer made some experiments with a single-phase furnace using about 650 kw., the ore used being a hematite containing from 50 to 52 per cent metallic iron. This furnace was operated for several weeks and the expenditure of energy per gross ton of pig iron produced was 2300 to 2400 kw.-hr. It will therefore readily be seen that to produce any considerable quantity of iron in the electric furnace large amounts of power will be necessary, and this, coupled with the fact that such an enterprise could only be operated under existing conditions, which are liable to change at any moment, has no doubt deterred investors from risking the capital necessary for such an undertaking.

The writer's own experience has not gone to show that any advantage has been gained either by lowering the expenditure of power or decreasing the gross cost of the product by the use of the shaft furnace, such as is used in Sweden, for unless the gases are utilized the shaft furnace becomes a complicated, expensive and unnecessary piece of apparatus. A well-designed ordinary electric smelting furnace with partial roof and automatic charging from overhead hoppers will produce a cheaper pig than the shaft furnace, and the first cost of plant would be considerably less.

With the war, however, a new industry has been created for the electric furnace, which owing to its practically low initial cost in plant and low power consumption, bids fair to become very popular, and that is the production of pig iron from shell turnings and shell scrap.

As the specifications for steel to be used in the manufacture of shells call for low phosphorus and sulphur, it is possible in the electric furnace to produce a low phosphorus pig iron from such scrap at a figure which, given the present selling price of low phosphorus pig iron, yields a handsome profit, while very little refining is necessary. Any type of steel furnace can be used for this process, and it is not even necessary to have a furnace of the tilting type when little refining has to be done, as by special manipulation of the slag in the furnace, a certain amount of phosphorus can be removed, and sulphur is always to some extent eliminated by the basic slag employed.

The possibility of this process was first brought to the writer's attention in the fall of 1916, and experiments were immediately undertaken in a small furnace at Orillia, Ontario. These experiments having proved the process to be a feasible one, a new single-phase furnace was built and has been in successful operation since January of the present year. From 6 to 7 tons of low phosphorus pig iron is being produced per twenty-four hours, the amount of power used on the furnace being about 250 kw.

Furnaces for this work have since been installed at St. Catharines, and Collingwood, Ontario, also at Shawinigan Falls, Quebec, and a number of furnaces are now operating in the United States.

At St. Catharines the furnace is of 6-ton capacity, three-phase operated by Packard transformers of 1200 kw., but only 700 kw. is being used at the present time,

owing to the shortage of power. The daily output is around 20 tons. It is estimated that the production will attain 35 gross tons with the full power of 1200 kw. The operation is in many respects similar to the making of steel in the electric furnace, the refining process for the elimination of phosphorus being somewhat different. The charge consists of shell turnings, the necessary carbon base, which may be charcoal, coke or coal, ferrosilicon and lime. Manganese is not added, as care is taken in the process to conserve the manganese already contained in the turnings. The furnace is of the fixed type, with a carbon bottom and silica brick lining; there are two charging doors and one tap hole, similar to what is used in open-hearth furnaces. The furnace is controlled by automatic regulators, which eliminate to a great extent manual labor on the furnace, besides giving a much steadier load than is possible by hand control. The product is cast in sand, the pig beds being placed about 30 ft. from the furnace. In our Orillia plant the iron is cast into iron molds, which make a better looking pig than sand casting. The return in iron as compared with the scrap charged is about 95 per cent, and as about 5 per cent is added to the iron in the form of carbon and silicon, the total loss is about 10 per cent of scrap charged. The pig produced is very tough and the analysis is fairly uniform, as can be judged by the following table of consecutive heats:

Heat No.	Silicon	Sulphur	Phosphorus
237	1.45	0.025	0.025
238	1.83	0.029	0.031
239	2.82	0.030	0.033
240	2.11	0.029	0.027
241	1.88	0.025	0.027
242	2.49	0.027	0.027
243	1.21	0.035	0.040
244	2.35	0.030	0.030
245	1.25	0.029	0.031
246	1.55	0.027	0.027
247	1.59	0.028	0.031
248	1.50	0.025	0.029
249	2.02	0.029	0.032
250	1.50	0.032	0.038
251	1.41	0.029	0.033
252	1.50	0.025	0.023
253	2.20	0.025	0.027
254	1.50	0.027	0.030

The carbon is very rarely over 3 per cent; from this point onward any extra carbon added is very destructive to the lining and roof of the furnace. A roof will last from 150 to 200 heats; the roof conditions are being gradually improved and 300 heats may yet be realized for one roof.

The process is not a new one, as attempts were made several years ago to make pig iron from scrap steel, but the cost was found to be prohibitive. The writer also made some experiments in operating the pig-iron furnace for ore, before mentioned, by mixing 50 per cent each of scrap and ore in the charge. The result was an increased production from about 6 tons on ore alone to 11 tons with the mixture. The same amount of power was used in both cases.

In passing, it might be said that some of the blast furnaces in the States are now mixing considerable quantities of steel turnings with the ore, in order to increase their output.

Whether this process will be feasible after the war and when normal conditions are again with us is not a settled point. The cost of production is at present high, and would be prohibitive under normal conditions. It must be remembered, however, that costs to-day are possibly 50 per cent higher than they were three years ago, and it is the writer's conviction that provided future experiments find a means of eliminating phosphorus from the iron without removing the slag, the process can be profitably operated in normal times, at least in Canada, where low phosphorus pig iron is always a dollar or two higher than in the United States.

In conclusion, although a little foreign to this paper, the writer would like to call the attention of all those interested in steel furnaces to the roof coolers, which are placed around the electrodes in order to keep the bricks at that point as cool as possible. Recent practice at St. Catharines has shown that the life of the roof can be prolonged materially by correct application of these roof coolers, especially the ring of bricks around the electrodes. These coolers should be made to the exact form of the roof, and should rest on the bricks which form the ring around the electrode, and not on any packing between these bricks and the cooler. They should not be flanged, but cast to a special form, so that the cooling water will be at an equal distance from all outside surfaces. The writer will be glad to give any further particulars to members who may be interested.

A paper by **Russell E. Lowe** of the Fitz Gerald Laboratories, Inc., Niagara Falls, N. Y., described a method for the commercial **analysis of ferrosilicon.** Rapid and accurate methods for the determination of sulphur, phosphorus, manganese, iron, aluminium and silicon. The usual elements found in 50 per cent ferrosilicon were given.

* * * *

Frank Thornton, Jr., described experiments on an **electric resistance furnace** with various resistors placed inside the furnace, either on the hearth of the furnace or on a shelf around the walls. The furnace was designed for heating steel commercially to forging temperatures. It was pointed out that such a furnace would have many other applications, such as heat treating, melting, firing ceramics, etc. Many difficulties were encountered in using granular resistor beds, and it was decided to try silica carbide blocks or slabs for the resistance material. The results were satisfactory and the furnace was operated successfully up to 1200 deg. C. for hardening tools and dies and for firing porcelain.

* * * *

The **Electric Furnace in the Norwegian Iron Industry** was described in an interesting paper by **Haakon Styri** of the Hussey-Binns Steel Company, Charleroi, Pa. The author reviews the development of the Norwegian iron industry and follows with an account of the introduction of electric steel furnaces and electric pig iron furnaces. Most of the furnaces in Norway are of the Rennerfelt type, although the Heroult furnace is being seriously considered by a new, larger concern.

In late years, in Norway, there has been a great desire to get iron and steel works which could produce shapes, plates and other commercial steel in order that the country might be more independent of imports. During the present war this need has been bitterly felt, as it is extremely difficult to get commercial steel from the belligerent countries, which formerly furnished it all. Many private corporations have investigated the possibilities of starting a modern steel plant, and much capital was expected to back the plans if they could be satisfactorily worked out, but the present soaring

prices of all new construction has put a stop to further important development. Another reason for little progress in the plans was the difficulty in working the different local interests together into a national interest, and the Government has not been favorable to electric furnaces.

The author states that conditions do not look promising for the production of steel on a larger scale in Norway. England and Norway have no duty on imported iron. He says:

"The prospects can, of course, change. It is possible that concentrate can be used direct in an electric reduction furnace, at least where little attempt is made to utilize carbon monoxide in the reduction of the ore, by using the gas instead for heating pig-iron mixers, where the main decarbonizing could be done, for melting of scrap, and for heating of by-product coke ovens. The gas from the coke ovens could be sold to the city. The steel product could be finished in an induction or arc furnace.

"Another method is now on trial, basing the operation on the direct use of low-grade ore by the Edwin-Westberg-Gröndal process. Interested Norwegians and Swedes have secured $150,000 for the purpose of testing the method on a commercial scale. The low-grade ore is crushed according to the structure, and is treated in the furnace with reducing gases which are heated outside in a high-tension arc furnace similar to the one used for the manufacture of saltpeter. The reduced iron is afterward separated magnetically from the rock, and the iron powder melted in an electric furnace. The successful iron and steel works in Norway have based their production on high quality of product. The manufacture of structural steel is not, and probably will not be tried in the near future, on account of the competition from foreign countries. What Norwegians want and look forward to is the time when the country can again furnish iron and steel which comes up to the old standard of Norway iron."

Electric Furnace for Brass Melting

T. F. Baily, president of the Electric Furnace Company of America, Cleveland, Ohio, described a resistance type furnace for melting brass and bronze.

The furnace is of the non-crucible type and operates on the true resistance principle. A general description of the furnace is as follows:

In a cylindrical shell, supported by the usual trunnions and brackets for tilting, is constructed suitable walls and roof forming the furnace chamber. The bottom of this chamber is so shaped as to make a bowl-shaped hearth for containing the metal when melted.

The resistance element is contained in a circular trough made of a refractory material similar to carborundum fire sand. In this refractory trough the resistance material, composed of broken carbon, is placed, forming contact with the electrodes which are placed diametrically opposite each other with their ends protruding into the circular trough.

The control of the current, and hence of the furnace temperature and melting capacity, is by means of suitable voltage taps brought out from the secondary of a special transformer supplied with each furnace.

Running tests were given of melting bronze and brass, with mechanical tests of the cartridge brass produced and numerous analyses showing the uniformity of the metal at the beginning and end of the cast. The electrical power required shows favorable comparison of melting costs with crucible or open-flame melting furnaces, the average being 450 kw.-hr. per short ton of bearing bronze (495 per metric ton), and 311 kw.-hr. per short ton of cartridge brass (342 per metric ton).

Pure Alloys for Magnetic Purposes

A paper by **Trygve D. Yensen** of the University of Illinois described an electrolytic plant for producing pure iron and discussed the reasons why pure iron and iron containing elements which do not separate its crystals from each other have great magnetic permeability and low hysteresis losses. Ordinary and vacuum electric furnaces for making the alloys at temperatures up to 1800 deg. C. were also described; also annealing furnaces for heat treatment of the alloys produced.

Influence of Temperature on Properties of Steels

A paper by **Edward D. Campbell,** emeritus professor at the University of Michigan, described the influence of temperature on the electrical resistivity and thermo-electromotive potential of steels. It will be published in full in our next issue.

Calorized Iron

Prof. **O. L. Kowalke** of the University of Wisconsin compared the thermoelectromotive force of couples of "calorized" iron-constantan with that of "uncalorized" iron-constantan. A sample of "calorized" iron wire from the General Electric Company gave the same thermoelectric potentials as "uncalorized" iron up to 1000 deg. C. on repeated calibration. A sample from the Brown Instrument Company gave slightly different potentials until after it had been heat treated at 800 deg. C., after which it gave similar results to the other "calorized" wire. The author concludes that a heavy wire, lightly calorized, gives as constant results as uncalorized iron, and has a much longer life.

* * * *

After a complimentary luncheon at the William Penn Hotel excursions were made to various industrial plants in the Pittsburgh district. A large party went to the American Zinc & Chemical Company at Langeloth, where they had an opportunity to observe the roasting and smelting of zinc ore and the manufacture of sulphuric and nitric acids, zinc sulphate and zinc dust.

Other parties visited the Research Laboratory of the American Sheet & Tin Plate Company, the Mellon Institute of Industrial Research, the University of Pittsburgh, the Carnegie Technical School and the Carnegie Museum.

Production of Electricity by Steam Power

On account of the prime importance of the power question in electrochemical and electrometallurgical industries, the Society invited Mr. ALEX. DOW, President of the Detroit Edison Company, to speak on the present status of the production of electric power from steam. Mr. Dow gave a masterly address of particular interest to the Society because he considered his subject from the viewpoint of electrochemical needs. From a stenographic report of his address we make the following excerpt:

You are more interested in power delivered and avail-

able for your work than you are in the question of generating or producing power at the terminals of a dynamo-electric machine; therefore, it will be necessary for me to talk discursively, to go into questions of distribution and transmission, and to some extent into the utilization of power in order to get before you the ideas which I think you expect me to present, namely, the present status of the production of electric power from steam, as I understand that status to be.

Let me make the point again, that delivered power and generated power are two different factors. Generated power is the actual power produced at the terminals of your machine; the output is the amount of power delivered into your trunk lines, or turned out from your station into the trunk lines. The difference between the two represents uses in the power house, lighting, heating, excitation, the operation of auxiliaries, and all the minor losses incurred in any power-plant output. The net power output is what the great majority of central-station men are concerned with.

In a close net-work, such as serving one big mill owning its own power-plant, the difference between the actual delivery to the points of use may be eight or ten per cent. In a complex works, covering a large area, and delivering power in different forms, the order of difference is more likely to be 20 per cent and upwards. That is to say, if the meters of a large central-statoin net-work account for 80 per cent of the current generated at the power-house, or of the output from the power-house, they are doing very well. The distribution efficiency is first-class.

Fuel cost is the one figure on which comparisons can be made, and fuel cost must be expressed in heat units to meet the comparison. These show year in and year out an approximation of 20,000 heat units per kw.-hr., with periods below and periods above it. In no case do they exceed the 20,000 figure, and when they get below it it is at very favorable seasons of the year. From the adaptation of the stoker and the furnace to the fuel it has been carried to the limit of our present knowledge.

Heat Balance—You should not throw heat overboard beyond what you can save. It is essential to get as much power out of the steam you make as is possible.

You will remember that something like eight-tenths of the heat units are hopelessly lost in the condensing system. Any heat process, therefore, which uses electric heat has an initial handicap if the electric heat is produced by combustion.

By our present methods you will never get higher efficiencies than that corresponding to 100 per cent efficient use of the electricity. You can approximate that, getting into the high nineties, but the electricity will represent only 81 or 82 per cent of the heat in the fuel. Therefore, in electrical heating, you use it because of electricity's other merits. And its large use proves that wise men are willing to pay for those other merits, and that fuel economy is not the only thing to consider in industry.

Put me down as saying that where electric heating is used and the origin of the electricity is in fuel, you are absolutely applying that heat wastefully, considered as an application of heat, and the wastefulness is hopeless. The loss overboard in the condensing water is the big thing. All other losses, radiant losses from boilers and engines are minor in comparison.

Cost of Power

The total cost is the fixed cost plus operating. It makes a division into standing and running cost, the standing cost being the station rate for service, and the running cost being the added cost due to service.

Let me say this: The fixed element is so very large that at poor load-factors it is controlling. That load-factor must come back to you time and time again. With some of you the load-factor is high; with others it is inclined to be low. The electrochemical load-factor is of the order of 90 per cent of what would be obtained if the maximum hours, that is 8760 hours, were obtained during the year.

You gentlemen are in the habit of telling us you have 100 per cent load-factor. Ninety per cent is going strong, and the eighties are more frequent. On the other hand a mixed service is doing well if it shows 40 per cent. Any central-station with the load-factor above 40 per cent is doing well, indeed. Below that is common.

The cost of money, plus the investment, plus the taxes, means that the central station must figure on a return never less than 12 per cent, and sometimes exceeding 15 per cent. So your first figure, based on the central-station method, is to figure 12 to 15 per cent as a figure on an investment per kilowatt, which was between $50,000 and $60,000, and which now is between 90 and 110 per cent.

Now, assume we have the problem put to me by some of your members, that you want a power-plant, the object being low total cost of power, and that you have some choice of location. The first thing to consider is how the location may affect the power-plant; and that leads into those engineering problems I wish to put to you.

With electrochemical industries, of course, you must consider your raw material and your markets. You must have good shipping points, you must have fairly good labor conditions, etc. These conditions would have a large influence in determining the location; but if you leave us free to transmit the power from a satisfactory location for the power-plant, if that be in the premises of this discussion, we can forget these considerations for the present.

Take item No. 1—the fuel cost. If the load-factor is of the order of 90 per cent, fuel cost will be the most important thing to consider. In connection with fuel cost you must consider the certainty of the supply—that it will not be interrupted.

Then you must have plenty of water. The quantity of water used by a big steam plant is something you do not conceive. A plant of 100,000 kw., operating at 50 per cent, will require to pass through its condensers approximately the same amount of water as will be used by a mixed residential, industrial and commercial community having a population of 750,000 people. In other words, my power plants take up from the river, heat to 10 or 15 deg. and reject to the river again, more water than is pumped for the whole community. Therefore, the water-supply is the next thing to consider after a good supply of fuel. You must locate on navigable rivers or streams, or on the Great Lakes. Cooling towers are devices you must forswear if you are working for maximum efficiency. One of the most appropriate places for a cooling tower is in the dry Southwest where the rapid evaporation of an exceed-

ingly dry atmosphere cools the water sufficiently and the night chill gives you a fair start the next morning. To locate a big plant on a country duck pond is foolishness.

The next consideration of importance is the labor condition. Power-house labor is changing its character very much. There was a time when the power-house got incipient geniuses; that was a mistake. But the day has come for brains, and they are being secured. To-day the power-house employees expect good pay and good environment.

The engineer now wants his shower when he goes off watch, and sometimes he calls his relief and takes a shower while his turn is on. You must supply first-class working conditions. These men expect their outside, off-work, conditions to be such as they can pleasantly live in when they are off watch, where the older men can bring up their families and the younger members can hope to persuade "the only girl" to come.

If you locate on a place where people consider the outer appearance you must think of an architect. I can think of three power-houses where the outside appearance is a credit to the public-spirit of the board of directors, while the inside is a libel upon the architect. Foundations will run to $5 per kilowatt when you locate in a marsh with rock 100 or 150 ft. down, and you must pile or go down to that rock; or if you locate on the Ohio River where you have 70 ft. of rise and fall, there you have a serious problem.

These things balance up. Low-fuel cost can be offset by good water-supply. It is better to go a little away from the coal to get better freight, etc. The big thing is whether you will locate close to your load or transmit.

Disadvantages of Transmission

Now, transmission is expensive. It has a very definite measure as to its capacity and a high figure as to its unit cost.

The right-of-way of your transmission line is another item of high cost. The line-loss may be a high cost.

Again, transmissions are not reliable. I have been considering that and lightning troubles. This was a year notable for lightning, when lightning was painful and frequent and free. We have such things as lightning arresters and they take care of secondary surges; but when you get a real direct stroke of lightning you go around with a shovel and clean up. Again, porcelain insulators are supposed to adjust themselves to all conditions of heat and cold while placed *inside* of a rigid cap, and are expected to stay put. Well, there are limits to human beings and there are limits to the elements which constitute these porcelains. Then you will find that lines which behaved splendidly for seven or eight years, after that time behave miserably.

So, another thing you must balance is unreliability. Then do not forget cyclones.

If you are generating by steam power it is probable that your big plant will be *per se* more reliable than any plant you can construct on your own premises; but the intervening link may change conditions. You must consider whether you want your process to hinge upon the unavoidable conditions which I pointed out, with the transmission line losses assumed at 15 per cent. That is high. You may spend money and cut it down. The distribution I spoke of is of the order of 20 per cent total.

I have here some figures in which the transmission loss is 18.7 per cent; of that 5.6 per cent is lost in the line, 3 per cent is lost in the substation transformers; loss in the synchronizer is one-tenth of 1 per cent; the current loss in changing from alternating to direct is four-tenths per cent, storage battery is of the same order; and then there are distribution losses, line transformers, meter shunts, and slow meters, etc.

Now, as to the question of location versus transmission, it turns not on the question of reliability or unreliability, as duplicate lines could reach that; it turns on your own problems of materials and markets. The answer is, if the power cost controls, you must get to your power-plant or bring the plant to you; otherwise you must consider the cost of materials and markets and then make the best adjustment you can between reliability, the location and your own conditions. It would be possible I think, I have said so to some of your members, to locate a considerable number of centers where a given adjustment could be made between all these conditions, and then the conditions of design would have to be predicated very closely.

If you come to generation only, 19,000 heat-units is entirely practicable. The missing figures which I had to show you would have made clear to you that the other operating costs are of the order of one-tenth per cent. You can figure the cost of your 19,000 heat-units.

As to gas fuel: Yes, there is a chance for betterment in gas fuel. You can control your mixture; lose no carbon in your ashes and have higher transmission values. But gas as a commercial proposition in almost all of the United States is entirely dependent for its cost upon the by-product market; and that as you know is anybody's guess. In the meantime gas-producers as an addition to boilers cost too much. No combination in present or recent conditions can be made that will allow gas fuel to be used in steam boilers. The gas-engine has its place. At present the large steam-turbine has it beaten. With free gas or natural gas the gas engine has its merits.

Pulverized coal must be considered in any new design. It is first-class now in locomotives because of the impossibility of firing by hand the present big machines. There is a better control of the air mixture; you cut off your fuel and that is the end of it.

The whole question of pulverized coal turns upon the point that it may make useful coal which with stokers of the present time are not useful. That may tend to reduce total power-cost. The big point is to adapt the plant design to the fuel you are going to use.

What I have told you of design for making steam efficiently is based on man-sized experiments in which were determined the upper and the lower limits. The rule of finding how far you could go before trouble started, and then how far in the reverse direction you could go after the trouble started is the only rule to give you anything proper. But to go in one direction a great way because a little has proven well is bad engineering.

Turbine Troubles

Now, turbine troubles exist of course. Your turbines, most of them, are fine ladies so to speak; treat them right and they will treat you properly; and if you do not they will have hysterics or the mechanical equivalent thereof.

There are few bad turbines. If you take 200 tons of

turbine and place it on a foundation it is well after six months' time to examine that turbine foundation to see if it has not settled. If you examine it you will see that the turbine has been telling you its message for the past six weeks and you have given no heed to it. A well-made piece of machinery, such as a turbine, requires on the part of those having it a little imagination to know what is going on on the inside.

Now, in closing: It is not good to prophesy, but I know some of you expect to hear from me whether I anticipate any great change in the art. I do not, just now. All I can say is: there is not in sight, any great change. Unless we can find the materials to take us into higher temperatures, we need not expect much change. Many of the losses are commercial which cannot be saved profitably. The losses necessary to give you the necessary draft; and the big losses of heat thrown overboard—they seem to be inherent in steam.

I have not told you all I know, but I have told you all I can crowd into a reasonable time, with a bad start.

Mr. Addicks opened the discussion by saying that if the electrochemist could give Mr. Dow a 100 per cent storage battery we could improve conditions greatly. He believed the day was passed when we will buy power from the central station and that the building of a steam plant for the special use of the electrochemist is the next idea in view. As a result of investigation he had reached the conclusion that if coal could be secured at $1.25 per ton at the mouth of the mine, power could be generated for $15 per horsepower year, excluding interest on the investment. This approximates the rates at Niagara Falls, but there is still hope that waterpower will show better costs than the steam plant is now doing.

Mr. **F. A. Lidbury** then spoke as follows:

In an address and discussion about eighteen months ago in Washington, Mr. Addicks took the view that we had better stop speaking of the waterpowers that existed in this country and turn our attention to steam because, as he then pointed out, it was going to be as economical to generate steam as to use waterpower. That view was not uncontradicted at the time, and might not have resulted in great attention being given at this time to this particular question by this society, had it not coincided with the shortage of power for electrochemical purposes which was then serious and has since become a national menace. Taking the figures Mr. Addicks gave at their face value, a number of us decided to look into the matter and see what could be done, for the situation seemed to be one which should not permit any stone to be left unturned.

In this particular matter we found the remarkable spirit of co-operation of the Detroit Edison Company, which has been so well exhibited in what Mr. Dow has said to-night. The matter was not taken up in the first place by Mr. Dow, but with Mr. Crosby; and through Mr. Crosby Mr. Dow got interested.

The result of the detailed conference we had with Mr. Dow at Niagara Falls was, I am sorry to say, that most of us lost interest in steam power under present conditions.

It seems to be a matter of general conclusion, that if we could revert to pre-war conditions, the thing would be worthy not only of general consideration but of serious detailed consideration. However, with things as they are, with prices of apparatus as they are, and particularly the price of coal as it is and as it will remain for some time, it would be impossible to go into it on any basis that could be considered commercial.

In other words, we jumped at the idea of steam power under improved modern conditions. As soon as we found what it meant, we jumped back as rapidly as we could.

Now, I always like to check things of that kind by facts, and the facts in recent months indicate that there is no tendency on the part of the electrochemical industry to go to something else. What we see to-day is the continuation of the process we have been watching for a number of years in an increasing degree, and will continue as far as we can see at present; and that is the expatriation of industries which exist primarily for the need of this country.

There is a national aspect to this matter. In the broad point of view it is very doubtful to what extent this country should permit the migration of industries which are as fundamental to its life as any others that can be mentioned. We have got to let these industries go, or we have got to treat the matter politically and decide they must be kept in the country by hook or by crook, at whatever price steam power might permit them to produce their goods, and impose a tariff sufficiently heavy as to be prohibitive. Or, the most sensible course, *to permit and to insist upon and to enforce the thorough-going utilization of our natural water power resources, which could solve this whole question inside of two or three years.* (Applause.)

We have been talking of improvement in this matter for four or five years, or even longer. We have had a respectful hearing in our own society. Outside we have been treated as cranks or as malefactors. The result is this country is faced with an alarming condition with respect to its productive power for a tremendous number of articles which are fundamental necessities for warfare.

Nobody realizes at this time the extent and the seriousness of this matter. Nobody realizes it because there does not exist even to-day in the Department in Washington any accurate knowledge of the quantities of materials and supplies which will be necessary and the production of which depends upon the electrochemical industries of the country. We will have a demonstration of the policy which this country has developed in regard to waterpower legislation, and the only hope we can express is that when matters do come to a sufficiently clear indication of the mess we are in, we will put ourselves in such a position that the same thing cannot occur again.

Friday Meeting

Reforms in Chemical Terms

On Friday the technical session was opened with a paper by Dr. **Carl Hering** of Philadelphia, in which he suggested several important changes in chemical terms. He has written several previous papers on this subject during the past two years, which have appeared in the columns of this journal. He summarized his work as follows:

"A more precise distinction should be made between different kinds of bonds. The term valence should be more strictly defined; negative and zero valences should be included. The proposed practical unit for measuring

electrons should be used. The ionized state should be considered as differing in kind from either the free or the combined state. Reduction should include all and only cases of reductions in valence, and oxidation all and only cases of an increase of valence, hence the new term adduction. The significance of the gaining and losing of electrons should be more clearly understood; the sign of electrode potentials is then more easily understood. As sometimes stated, Faraday's law is not a universal one, and it is a corollary of a more basic one."

Radium and Chlorine in Warfare

Messrs. **Charles H. Viol** and **Glenn G. Kammer,** research chemists of the Standard Chemical Company, Pittsburgh, Pa., describes briefly the sources and extraction of radium and discussed its use in warfare. The principal uses are in therapy and as luminous paint for many purposes. This luminous paint has been found very useful in warfare. The authors stated that it consists principally of crystalline hexagonal zinc sulphide with 0.215 mg. of radium per gram of sulphide.

The use of chlorine in war was described by **Wm. D. Marshall,** who took up its use in sterilizing drinking water and in making hydrochlorite solution for field use.

In discussion of this paper Mr. **Schulte** presented a brief description of a simple apparatus for sterilizing water with chlorine. The apparatus consisted of two carbon electrodes between which was pressed filter paper saturated with sodium chloride. The apparatus was designed to be used in connection with small dry cells. To illustrate the efficiency of the apparatus Mr. Schulte gave a number of examples of effective sterilization of lake water.

Electrochemical Gasoline

An interesting set of experiments was described by **Louis B. Cherry.** The experiments were made to support a theory of the synthetic production of gasoline by electrochemical and electrothermal means. It was thought possible that by uniting in proper proportion and form sufficient methane or hydrogen gas to certain of the heavier hydrocarbons that synthetic gasoline could be produced. Natural gas was suggested as a source of methane. The gas and oil vapors were subjected to a high-voltage oscillatory high-frequency current, in treatment chambers made of 1 in. (2.5 cm.) pipe which had been plugged and reamed, the ends of which were fitted with modified spark plugs which served to lead in the current through a fine No. 30 (0.25 mm.) platinum wire, which wire passed through the center of the pipe from end to end, and which, when connected to the high-frequency coil, subjected the gas and oil vapor, passing through the pipe, to a silent electric discharge, alternating back and forth, between the central electrode and the pipe, and at right angles to the direction of the flow of gas.

This was a very crude equipment, without pyrometers or pressure gages, and was operated at high pressure and high temperature, but it served to demonstrate the feasibility of the process, by converting 42½ deg. Bé. kerosene into 65 deg. Bé. gravity gasoline. This was done at high pressure and temperature, and was operated for several hours before the equipment exploded, completely wrecking the small frame building in which it was located.

A plant was then designed to convert one gallon of oil per minute. The still was of pipe construction, 4 in. (10 cm.) double-extra-heavy pipe, welded flanges, electrically heated, and consumed about 40 kva. of electrical energy at 60 volts, using 60-cycle alternating current.

Electric power was brought in at 110 volts, and by means of an autotransformer, arranged with twenty-five 3-volt taps connected to a switchboard panel equipped with a special rotary switch with twenty-five contact points or clips (see Fig. 2), control of the heat was very sensitive. The oscillatory electrical generating apparatus for this plant consisted of 1-kva., 110 to 25,000-volt step-up transformer, with a variable reactance in the primary, a variable condenser, rotary spark-gap and oscillatory transformer.

The difficulties encountered with operation under high pressure were so great that it was decided to carry on experiments under atmospheric pressure. A larger plant was then built, the chief difficulties being in designing high-frequency apparatus to produce current of several hundred thousand cycles per second, a potential upwards of a hundred thousand volts, current generating capacity of three to five amperes at the above voltage, and to build the equipment so reliable that it could be operated continuously twenty-four hours per day and seven days per week.

The step-up transformer was designed of the closed-core type, 110/220-50,000/100,000 volts, and rated at 30 kva., but with a real capacity of 75 kva.

In the design of the oscillatory transformer it was decided to use a vertical transformer case composed of porcelain 4 ft. (1.2 m.) in height, 14 in. (35 cm.) greatest outside diameter, and with a wall 1 in. (2.5 cm.) thick.

This high-frequency equipment is mounted on a gallery about 8 ft. (2.4 m.) above the main floor, and is capable of the widest range in operation, being capable of producing high-frequency current from 15,000 to about 250,000 volts, and has a capacity of converting into gasoline about 60,000 gallons of oil in one day of twenty-four hours.

Experience with the first plant with its 3-ft. (0.9-m.) treatment chambers proved they were not sufficiently long, so in building this second plant the treatment pipes or chambers were built with a total length of 10 ft. (3 m.). For experimental purposes a seven-barrel still is used, which is fired with natural gas, and the vapor outlet of the still is connected to the treatment chambers.

These pipes are heated by induction, being wound their entire length with double 0 copper cable (9 mm.) electrically insulated with a special fireproof insulating compound, and connected to an autotransformer similar to the one used in the first plant.

On operating this equipment, a 78 per cent conversion was made from kerosene, and as this was not considered ideal, it was again decided to increase the length of the treatment chambers to 34 ft., which should give an efficiency approaching 100 per cent conversion.

In order to successfully put the process into commercial operation it is planned to build treatment chambers adjacent to the crude-oil stills now installed in the various refineries in the country, connect them to the vapor line of the stills, put a perforated gas pipe in the bottom of each still for the admission of natural

gas, and after the first benzine "cut" is made, divert the vapors of the heavier fractions through the treatment chambers, which, when mixed with the natural gas which has been admitted by the perforated pipe, may be converted into a crude benzine similar to that which was first taken from the crude oil.

As stated at first, the density of the product may be changed by varying the frequency of the oscillatory current, but by experiment it has been discovered that the product may be more easily changed in density by varying the temperature of the treatment chambers, and in so doing one would expect that a temperature might be reached which would break down or "crack" the oil vapors with the attendant precipitation of carbon; but so far this trouble has not been experienced, although temperatures have been carried up to 480 deg. C. (about 900 deg. Fahr.). Had this temperature been carried without the presence of the high-frequency current, precipitation of carbon would have been very rapid, and an ill-smelling product consisting largely of the olefines would have been the result.

Apparently the ionizing effect of the heated tubes combines with the effect of the high-frequency current, and produces a resultant effect upon the gases and oil vapors, disorganizing, and at the same time reorganizing their molecular formation, this being done without complete separation of their elements.

It is predicted that the aromatic hydrocarbons, such as benzol and toluol (which are in so great demand at present for the manufacture of dyes and explosives) will be made by some modification of this process.

Some experimenting has been done in this line, with kerosene (without the addition of natural gas), under a pressure of 80 lb. per square inch (5½ atmospheres), and a temperature of the treating chambers of 538 deg. C. (1000 deg. Fahr.), which produced a distillate which seemed to be composed largely of a mixture of benzol and toluol. Complete refining and rectification of these products were not made, but their reaction with different reagents and their ability to dissolve asphaltum indicated a high percentage of these two compounds. Further investigation along this line is contemplated in the near future.

Spectroscopic Determination of Lead

The authors of this paper, **C. W. Hill** and **G. P. Luckey**, described a rapid method of determination of lead in factory samples of copper. A known weight of copper is placed in a slight cavity in a lower positive graphite electrode, and a fixed or rotating carbon negative electrode used above. A grating spectroscope serves to observe the spectrum. The time required to cause the disappearance of the bright lead line in the spectrum, or to cause its enfeeblement to a certain dimness, is measured with a stop-watch. With carefully regulated arc, the times vary regularly with the amount of copper used and with its percentage of lead, *e.g.*, from fourteen seconds with 0.2 g. copper containing 0.004 per cent lead to 277 seconds with 1 g. copper containing 0.038 per cent lead. The results are sufficiently reliable for practical use in the copper refinery.

Mr. W. R. Mott stated that those metals which formed beads and did not "wet" the arc or dissolve the carbon to any appreciable extent were most amenable to the method described. These include the following metals given in the order of their boiling points: As, Cd, Zn, Tl, Bi, Sb, Pb, Ag, Sn, Cu and Au. For analytical purposes the better combination would be of those metals having widely separated boiling points. Thus the following combinations would not give complete separation: As and Cd, Bi and Pb, Sn and Cu.

Copper Castings for Electrical Purposes

In a paper on this subject **W. M. Corse** and **G. F. Comstock** of the Titanium Alloy Steel Company, Niagara Falls, reviewed the progress in refining which permitted efficient transmission of electricity with negligible losses due to resistance. They cited early work of Matthiessen and the consequent improvement in conductivity from 50 per cent to 100 per cent. They reviewed Addicks' work on effect of impurities on electrical conductivity of commercial copper and contrasted the possibility of getting copper wire of high conductivity with production of castings of equally good conductivity. For the former it is necessary only to start with pure copper bar. With the latter there are difficulties due to rapid absorption of oxygen and other gases when copper is melted with formation of copper oxide. When the metal freezes, blowholes are formed due to evolution of the gases, and films of copper oxide are formed as an eutectic between the grains of metal. These films and blowholes impair the conductivity of the metal.

In order to make sound and strong castings foundrymen have usually added an impurity, such as zinc, so that strength is obtained at the expense of conductivity. The authors have experimented with silicon as a deoxidizer, finding it superior to zinc. They have made complicated and large sand castings of pure copper having 75 to 85 per cent conductivity as compared with 40 per cent to 50 per cent usually obtained with zinc. Castings are soft and weak, but they hope eventually to get strength without losing the conductivity.

In the discussion **Mr. H. E. Randall** stated that the addition of 0.2 to 0.3 per cent of magnesium aids in the production of copper castings with satisfactory conductivity.

Electrolytic Copper

In a paper on the electrolytic recovery of copper and sulphuric acid from copper mill pickling solutions, **J. L. Jones**, metallurgist of the Westinghouse Electric & Manufacturing Company, described the percipitation of copper from waste copper sulphate pickling solutions by iron scrap, also of neutralizing the excess of acid and evaporating down to copper sulphate crystals (bluestone). He then described an electrolytic plant for extracting the copper in a pure condition and regenerating the acid for re-use. The acid content is run up to 20 per cent and the copper content reduced to about 1 per cent. Some of the copper is deposited directly on steel plates as copper plating, but most of it is collected as cathodes for re-melting.

Electro-Analysis

A new electro-analysis apparatus for non-ferrous alloys, was described by **J. L. Jones** in another paper. It has been in use in the laboratory of the Westinghouse Electric & Manufacturing Company for about two years. One ten-unit and two six-unit machines have been built and are now in use. They are electrically stirred. The electrodes and beakers are fixed and stirring is done by revolving tungsten rods. Each analysis

receives its own current, graded by a rheostat from 0.5 to 6 amperes. A switch and push-button at each beaker enable the amperage and voltage to be determined at any time.

Lithium in Storage Batteries

L. C. Turnock of the Carnegie Institute of Technology, Pittsburgh, Pa., described an investigation made to determine the magnitude of the effect of various additions of lithium hydrate to the potassium hydrate electrolyte of the Edison storage battery. Comparative tests of capacity of Edison storage batteries were made with 0, 10, 20, 30, 40 and 50 grams per liter of lithium hydrate added to the usual 21 per cent caustic pot-ash electrolyte. Test runs showed increased capacity up to 12 per cent with the largest amount of lithium hydrate, in spite of the fact that the addition increased the electrical resistance of the electrolyte 21 per cent.

In reply to a question by Prof. Bancroft as to whether both electrodes or only one was affected, the author stated that while the point had not been definitely determined he was of the opinion that it was the positive electrode.

Corrosion of Fence Wire

The results of a large number of investigations on this subject were described by **Oliver W. Storey** of the C. F. Burgess Laboratories, Madison, Wis. Important conclusions were drawn from the work and are given by the author as follows:

1. It has been definitely established that the durability of old steel fence wire is due to the presence of copper.

2. Manganese does not increase the corrosion of steel, and its absence does not decrease the corrosion.

3. The copper in the early steel and wrought irons came from the copper-bearing ores of the eastern United States and imported ores. The proportion of copper-steel made decreased with the increasing importance of the copper-free Lake Superior ores.

4. Steel fence-wire containing copper is as durable as wrought iron.

5. Present-day steel fence wire usually does not contain copper, and therefore corrodes rapidly.

6. Under ordinary atmospheric conditions zinc corrodes more slowly under conditions favoring rapid corrosion of iron, and *vice versa*, iron corrodes more slowly under conditions favoring rapid corrosion of zinc.

7. The life of fence wire is dependent upon the quality of both the galvanizing and iron or steel base. Since the galvanizing is usually thin, the life of the fence depends principally upon the iron or steel base, which should be highly resistant to corrosion.

Mr. **F. N. Speller** pointed out that each corrosion problem must be treated individually and that a successful method of meeting one condition could not necessarily be applied to another. Thus sheets and pipes of copper-steel show the same resistance as barbed wire so far as external or atmospheric corrosion is concerned, but pipes carrying water will show marked internal corrosion. The difference is ascribed to a variation in the relative quantities of moisture and oxygen present.

Mr. **T. D. Yensen** cautioned against jumping at broad conclusions in interpreting incomplete data on corrosion. He also emphasized the point that the resistance of copper-steel would vary with the conditions, particularly with the variation in the relative quantities of electrolyte (moisture) and depolarizer (oxygen) present.

Mr. **Buck** corroborated Mr. Storey's work and showed numerous samples of barbed fence wire with the analysis of their copper content. It had been his observation that while copper-steel wire would show initial surface rust, the formation tended to slow up and almost stop in from 10 to 15 months, whereas ordinary steel wire would continue to disintegrate. Copper-steel wire seems to form a protective coating that prevents further loss in weight. In reply to a question by Dr. Flint regarding the effect of salt-laden atmosphere or solution on copper-steel, Mr. Buck replied that he had found all steels to disintegrate in brine solution, but that in some experiments conducted in Atlantic City copper-steel resisted corrosion better than ordinary steel and that the comparison was about the same as in other atmospheres.

Electrolytic Pickling

The effect of the electrolytic pickling process on the physical properties of iron and steel was discussed by **John Coulson**, of the Westinghouse Research Laboratory, East Pittsburgh, Pa.

To determine the embrittling effect of absorbed hydrogen upon steel pickled in different ways, samples of spring steel wire were pickled chemically by simple dipping in acid, also by electrolytic pickling, using them as cathodes or as anodes. Oscillation tests on the original wires, the same sand-blasted, and the three sets treated as described, showed the chemically cleaned and the cathodically cleaned to be very brittle, while the anodically cleaned had the strength of the original samples. Similar tests were also made with drill-rod steel, hot-rolled Bessemer, and cold-rolled steel, after which mechanical tests were made as to strength, elongation and reduction of area. The chemically and the cathodically cleaned speciments again showed greater brittleness, which was most marked with the high-carbon steels and less marked with the soft steel.

Brittleness in Steel Springs

T. S. Fuller, of the Research Laboratory of the General Electric Company, Schenectady, N. Y., described interesting experimental work on the cause and prevention of brittleness in electroplated steel springs. The author does not agree with M. de Kay Thompson and C. W. Richardson (see this journal Vol. 16, p. 83) that hydrogen is not the cause of the trouble. He says:

The facts are all in accord with the assumption that the absorption by steel of atomic or nascent hydrogen liberated at the cathods is the cause of the embrittlement of steel springs in the plating bath.

This embrittlement may be prevented by first dipping the springs in a bath of molten tin. The tin forms a coating on the steel which is impermeable to atomic hydrogen. Rosin may be used as a flux in the tin dipping. The springs may be sand blasted, but must not be pickled in acid.

Steel springs may be dipped in molten tin at a temperature of 260 deg.—300 deg. C. without appreciably changing their mechanical properties.

In the author's experimental work he tested the

breaking strength of seven untreated springs, then tested similar ones electrically copper plated, pickled in sulphuric acid, and tinned by dipping in molten tin and then copper plated. The pickling makes them brittle, also copper plating, but tin-dipping before copper plating is found to prevent embrittlement entirely.

Corrosion of Metals by Acids

Oliver P. Watts and **Newton D. Whipple** of the University of Wisconsin described an interesting study of the rate of solution of zinc, amalgamated zinc, iron, copper, silver and gold, in various solutions at normal pressures and under a vacuum. The theoretical deductions are as follows:

1. The hypothesis of one of the authors, presented to this Society in a previous paper,[1] that the protective effect of arsenic on the corrosion of iron by sulphuric acid is due to polarization by hydrogen, is confirmed by the following facts:

(a) The corrosion by acids of iron protected by arsenic was invariably greatly stimulated by oxidizing agents.

(b) Arsenic does not protect iron from attack by corrosive agents which evolve no hydrogen by their action.

2. Amalgamation protects zinc from corrosion by acids because the discharge potential of hydrogen on mercury exceeds the potential of zinc. Protection by arsenic and by amalgamation are alike in their nature.

3. Tin and lead are only very slowly dissolved by non-oxidizing acids, although their potentials are such as would cause their ready solution in acids, if it were not for the unusually high discharge potential of hydrogen on them. Removal of hydrogen by an oxidizing agent causes these metals to dissolve readily in acids that otherwise corrode them very slightly.

4. Corrosion by acids, of metals below hydrogen in solution pressure or position in the usual electrochemical series, *viz.*, copper and silver, has been caused by the presence of oxidizing agents, and the reason for this action has been set forth in detail.

5. The oft-quoted statement that the corrosion of amalgamated zinc in dilute sulphuric acid is accelerated by a vacuum, has been shown to be incorrect. By removing the depolarizing oxygen of the air, reduction of pressure retards corrosion, not only of amalgamated zinc, but of other metals whose solution is hindered by a polarizing film of hydrogen.

6. As regards corrosion by acids, the metals experimented with, and probably all others, may be classified as follows:

(a) Metals whose potentials exceed the discharge potential of hydrogen on them; these dissolve readily in acids, except such as form insoluble salts.

(b) Metals whose potentials are less than the discharge potential of hydrogen on them; these dissolve readily in acids only in the presence of oxidizing agents. Gold and platinum are not readily attacked by the acids in general, even when these contain oxidizing agents.

7. The superiority of nitric over other acids as a general solvent for the metals—long recognized—is due to its being at the same time an acid and an oxidizing agent, which enables it to dissolve metals of the second class, which non-oxidizing acids cannot do.

8. Oxygen is necessary to success in cyaniding gold ores because in dilute cyanide solutions gold is a metal of the second class.

9 Measurements of the discharge potential of hydrogen in solutions of potassium cyanide and sodium hydrate, and experiments on the corrosion of metals in the latter, lead the authors to think that the above classification of metals, the action of oxidizing agents, and protection by other metals, will apply to the *dissolving of any metal in any electrolyte* from which it displaces hydrogen when passing into solution.

10. The above classification of metals according to the relative magnitude of their potentials in comparison with the discharge potential of hydrogen on them, applies not only to the solution of metals, but to their electrolytic deposition. Plating baths for depositing metals of the first class cannot be strongly acidified without causing the deposition of much hydrogen in place of an equivalent amount of metal; but a large proportion of acid may be added to solutions for the deposition of metals of the second class without greatly lowering the current efficiency through the deposition of hydrogen.

Mr. F. N. Speller stated that the principles discussed in the paper by Watts and Whipple had a bearing on the problem of the destruction of hot-water pipes carrying water for domestic use at 60 to 80 lb. pressure and a temperature of 160 deg. Fahr. He discussed experiments started several years ago on the removal of free oxygen from a hot-water system by running the water through chambers filled with sheets of expanded metal affording contact with a large surface of steel. By circulation of the hot water the steel sheets became corroded and the free oxygen was consumed primarily in keeping the surface of the plates active. The excess of hydrogen goes into solution. Soluble gas collected from this water gave the following analytical result:

	Raw	Treated
O	*17.6%	1.59%
H	0.3	22.17
CO_2	0.3	.12
N (by difference)	81.8	76.12
Temp.	160 deg.F.	162 deg.F.

*Low due to corrosion of iron storage tank and connections.

Free oxygen in the domestic water supply usually ranges between 5 and 9 cc. per liter, to which extent its depolarizing power is limited. After passing through the steel plates the water carries from a trace to 0.2 cc. of oxygen per liter. Improvement in the system described was noted by the absences of leaks which formerly were of weekly occurrence. New pipes installed for the test show practically no corrosion with the use of this "passive" water. The unbroken element of hydrogen on the inside of a pipe system of this kind is probably a more protective coating than any other so far devised.

Silver Peroxide

H. C. P. Weber, of the Westinghouse Electric & Manufacturing Company, in a paper on this subject discussed the black compound formed on the anode during the electrolysis of silver nitrate solution, and to which the formula $2Ag_2O_2 \cdot AgNO_3$ has been ascribed. He discussed the probable valence of silver in the oxide part of this formula, writing it either Ag_2AgO_4 by analogy to red lead, or $Ag(AgO_2)_2$ by analogy to magnetic iron oxide. His various electrolytic experiments lead him

[1]Trans. Am. Electrochemical Soc. (1912), 21, 340.

to conclude that the last formula, $Ag(AgO_3)_n$, in which one-third of the silver is cathodic and diatomic and two-thirds anodic and triatomic, is in harmony with his experimental results. This would make Ag_2O_3 the silver salt of an argentic acid.

Catalysis

Two papers on this subject were presented by Dr. **W. D. Bancroft** of Cornell University. The first paper was on the theory of contact catalysis. The general conclusions drawn by Dr. Bancroft follow:

1. Only those substances which are adsorbed by a solid are catalyzed by it.

2. While the catalytic action of solids may be solely the result of the increased surface concentration in some cases, this is not always the only factor.

3. A solid catalytic agent may be considered as equivalent to a solvent and may therefore displace the equilibrium.

4. As a result of selective adsorption we may get different reaction products with different catalytic agents.

5. A catalytic agent tends to produce the system which it adsorbs the more strongly.

The second paper was on the poisoning of catalytic agents and led to the following interesting conclusions:

1. Since contact catalysis involves adsorption, a decrease in the adsorption will mean a decrease in the reaction velocity, other things remaining the same.

2. The adsorption may be decreased by the presence on the solid catalytic agent of a film of solid, liquid, or gas.

3. Very small amounts of grease will keep palladium from taking up hydrogen.

4. Carbon monoxide cuts down the catalytic action of platinum on oxyhydrogen gas and is itself oxidized slowly.

5. The preferential oxidation of carbon monoxide is not the reason for its poisoning the catalytic action of platinum on oxyhydrogen gas.

6. Carbon monoxide is retained tenaciously by platinum, and carbon monoxide practically destroys the catalytic action of platinum on hydrogen and ethylene.

7. Carbon monoxide undoubtedly decreases the adsorption of hydrogen and ethylene by platinum, though there are no direct measurements to show this.

8. Since the presence of the reaction products will decrease the rate at which the reacting substances will diffuse to the catalytic agent and since the reaction products may decrease the adsorption of the reacting substances, the reaction products may decrease the reaction velocity if they are not removed.

9. The reaction between carbon monoxide and oxygen in presence of platinum is accelerated by the addition of caustic potash to remove the carbon dioxide.

10. Sulphur trioxide decreases the rate at which sulphur dioxide and oxygen react.

11. If one reacting substance decreases the adsorption of the other, very much, presence of an excess of the first may decrease the reaction velocity.

12. When a mixture of carbon monoxide and oxygen is catalyzed by quartz glass, an increase in the concentration of the oxygen increases the reaction velocity, but an increase in the concentration of the carbon monoxide decreases it.

13. Since the poisoning of the hydrogen peroxide catalysis is due to selective adsorption, there is no necessary reason why the same substances should poison both platinum and haemase or should poison them to the same extent. On the other hand there is no reason why there should not be a certain parallelism, and that is all that actually occurs.

14. When a colloidal metal is kept in suspension by the addition of gelatine or other substance, the stabilizer may cut down the adsorption and consequently may tend to decrease the reaction velocity.

15. If the retarding effect due to the stabilizer in greater than the accelerating effect due to increased surface, a stabilized colloidal metal may be less effective than a pulverulent metal which is not handicapped by a stabilizer.

16. The action of mercuric cyanide, etc., in cutting down the electrolytic oxidation of thiosulphate is probably due in part to its decreasing the adsorption of thiosulphate at the anode.

In the discussion of this paper Dr. Fink pointed out that in 1907 he had published work on "Kinetics of Contact Sulphuric Acid," and "Adsorption Theory" which brought out the same ideas given in Professor Bancroft's papers. Acknowledging the excellence of Dr. Fink's early work, Professor Bancroft suggested that it was too far in advance of the thought of that time to receive the recognition it deserved.

Electrolytic Zinc

A paper on "The Future of Electrolytic Zinc" by **Thomas French** of Nelson, B. C., was read in abstract by Mr. Frary. It is hoped to publish this paper in full or a long abstract in a later issue.

* * *

At the close of the session the Society unanimously voted its thanks to the educational institutions and industrial organizations of Pittsburgh which had contributed so much to the success of the meeting.

In the afternoon, excursions were taken to various industrial plants in the Pittsburgh district including the benzol and by-product coke plant of the Briar Hill Steel Company and the new laboratory of the Youngstown Sheet and Tube Company, both at Youngstown, Ohio; the Atlantic Refining Company, Pittsburgh; Owens Bottle Works, Sharpsburg; Republic Chemical Company, Neville Island; and the Radium Research Laboratory of the Standard Chemical Company, Pittsburgh.

The banquet in the evening at the William Penn Hotel was a brilliant and enjoyable function. The evening was enlivened by cabaret and vaudeville entertainment features. Following the banquet Mr. Charles S. Witherell, recently returned from Chile, gave an illustrated talk on the plant of the Chile Copper Company, at Chuquicamata, Chile. Three reels of moving pictures were shown covering the mining and metallurgy.

On Saturday there was an all-day excursion by special train, with complimentary luncheon, through the manufacturing centers of the Pittsburgh district. This included the plant of the Westinghouse Electrical and Manufacturing Company, the National Tube Company, Duquesne Works of the Carnegie Steel Company, and the American Window Glass Company.

The Society is greatly indebted to the Pittsburgh local committee for the elaborate and painstaking arrangements made for the meeting.

Fractional Combustion*

By Wilder D. Bancroft

We may consider platinum black saturated with hydrogen, carbon monoxide, ethylene, methane, or oxygen as hydrogen, carbon monoxide, ethylene, methane, or oxygen electrode and from a measurement of electromotive forces, we can determine which one of the first four gases should oxidize the most readily in presence of platinum. So long as we assume that no one of the gases interferes with any of the others in a mixture we can predict what a mixture will do. If, however, a mixture does not behave in the way it should, there is a factor which we have overlooked in our calculation of the electromotive forces. If we consider the platinum, as we usually do, as a means of letting the chemical affinities have free play, the relative oxidizability of the different gases should be the same in presence of and in absence of platinum. If there is a difference in the two cases, the question at once arises to what extent the electromotive force calculated from the free energy of hydrogen and oxygen is really the true electromotive force of the hydrogen and oxygen gas cell. It is not my intention to answer either of these questions in this paper. I merely bring them up to show that a study of the theory of fractional combustion may be essential to a proper understanding of some electrochemical problems.

Many years ago Henry[1] made an interesting study of the effect of platinum on the fractional combustion of gases. Hydrogen and oxygen combine readily at ordinary temperatures in presence of platinum; carbon monoxide and oxygen react extremely slowly under the same circumstances; and neither ethylene and oxygen nor methane and oxygen react at all. When a mixture of methane and oxyhydrogen gas is exposed to platinum, the hydrogen burns and the methane does not. When a mixture of ethylene and oxyhydrogen gas is placed in contact with platinum some of the ethylene always burns. When a mixture of carbon monoxide with oxyhydrogen gas is exposed to platinum, there is a very slow reaction, the carbon monoxide burning more readily than the hydrogen.

Hydrogen is absorbed by platinum more strongly than ethylene and consequently it tends to burn first. Since ethylene does not burn at all under the same circumstances, it is possible, though not probable, that the combustion in presence of hydrogen is due to the oxygen passing through some intermediate stage in which it oxidizes the ethylene. That would make this an induced reaction. It seems to me more probable that we are dealing with a case of local heating, the ethylene burning at the higher temperature thus produced. This is the more probable since more ethylene is burned the greater the ratio of oxyhydrogen gas and the greater the ratio of oxygen. In fact Henry found that ethylene, when mixed with sufficient oxygen, began to burn in contact with platinum sponge at about 250 deg. and was converted completely into carbon dioxide at about 270 deg. Lunge and Harbeck[2] have shown that carbon monoxide is retained very tenaciously by platinum. It should therefore burn before hydrogen, and so it does. Methane is undoubtedly absorbed much less than either hydrogen or carbon monoxide, and this is in line with the fact that it is burned less readily under these circumstances.

Henry based a method of gas analysis on these observations. He found that by regulating the temperature carefully "the action of oxygen upon several gases (carbonic oxide, olefiant gas, and carburetted hydrogen, for example) may be made to take place in succession; and by removing the carbonic acid formed at each operation, it may be ascertained how much of each of the first two gases has been decomposed. The carburetted hydrogen indeed always remains unchanged, and its quantity must be determined by firing it with oxygen by the electric spark. If hydrogen also be present, it is difficult to prevent the olefiant gas from being partially acted upon; but this is of little consequence, as I had shown that it is easy to remove that gas in the first instance by chlorine."

This method of Henry's was afterwards worked out in more detail by Hempel,[3] substituting palladium for platinum. A mixture of hydrogen with an excess of oxygen burns completely when passed over palladium. The reaction begins spontaneously at ordinary temperatures, but so much heat is evolved that the palladium glows and the gases explode in case they are present in the ratio to form water. When methane and oxygen are passed over palladium at 100 deg. no combination takes place. The reaction starts at about 200 deg. Thus there was a contraction of 3 c.c. when a mixture of 29.3 c.c. methane and 70.6 c.c. oxygen was passed several times over palladium at about 200 deg. to 220 deg. When a mixture of hydrogen, methane, and air is passed over palladium at ordinary temperatures or at 100 deg., the hydrogen alone is burned and the methane remains unchanged, provided precautions are taken so that the palladium does not heat up too much.[4]

If a mixture of hydrogen and methane is passed over copper oxide at 250 deg., the hydrogen is burned completely, while the methane is not oxidized at all.[5] This method is said[6] to be distinctly superior to the fractional combustion of hydrogen by palladium or palladium asbestos because no air or oxygen is added to the combustible gas, which makes it possible to pass the total gas residue through the tube with consequent gain in the accuracy of the analytical results.

In view of the comparative readiness with which methane can be separated from hydrogen by the fractional combustion of the latter gas, it is not surprising that people came to the conclusion that hydrogen always burns more readily than methane. From experiments on the burning of illuminating gas, Landolt[7] concluded that in the flame "the gases disappear in the order of their combustibility. Hydrogen burns more readily than any other gas and consequently disappears the soonest in the flame. Marsh gas disappears somewhat more slowly, and the denser hydrocarbons disappear latest, burning chiefly in the upper half of the flame." It has been pointed out by Bone[8] that Landlot's results are vitiated by the fact that he used a platinum tube of

*A paper presented at the thirty-second general meeting of the American Electrochemical Society in Pittsburgh, Oct. 3-6, 1917.

[1] Phil. Mag., 65, 269 (1825).

[2] Zeit. anorg. Chem., 16, 50 (1898).

[3] Ber. deutsch. chem. Ges., 12, 1006 (1879).

[4] *Cf.* Hempel; Zeit. angew. Chem., 25, 1841 (1912).

[5] Jäger: Jour. Gasbeleuchtung, 41, 764 (1898).

[6] Dennis; Gas Analysis, 199 (1913).

[7] Pogg. Ann., 99, 411 (1856).

[8] Phil. Trans., 215, 297 (1915).

narrow bore, fixed along the vertical axis of the flame for the withdrawal of the partly burned products.

Henry's experiments showed that carbon monoxide burned before hydrogen when in contact with platinum at relatively low temperatures and that hydrogen burned before carbon monoxide when the gases were exploded by an electric spark. This last remark is confirmed by Bunsen's experiments[9] given in Table I. More hydrogen is burned than carbon monoxide until the ratio of the second to the first is at least six. Henry[10] is quite explicit that the preferential burning of carbon monoxide in presence of platinum at 150 deg. to 170 deg. and the preferential burning of hydrogen when the gases are fired by the electric spark is merely a question of temperature. Presumably Bunsen and Landolt held the same view because they do not comment on the low temperature results, which they probably would have done had they considered these results abnormal.

TABLE I.

Volumes Before Firing			Ratio of $H_2O:CO_2$
CO	H_2	O_2	
7.36	2	1	0.85
5.98	2	1	1.08
4.87	2	1	1.28
5.03	2	1	1.29
3.90	2	1	1.53
2.82	2	1	1.83

A new light has been thrown upon the phenomena by Bone [11] and his co-workers. Bone was primarily interested in the way in which a hydro-carbon burns in a supply of oxygen insufficient to oxidize it completely to carbon monoxide and steam; but, as is usually the case, the scope of the investigations soon became much broader. A mixture of oxygen and the gas to be studied was sealed in cylindrical bulbs of borosilicate glass with capillary ends; the bulbs were then kept at constant temperatures between 300 deg. and 400 deg. for several days in an air bath until the whole or a part of the oxygen had disappeared. The lowest temperature at which a reaction between methane and oxygen could be observed after the lapse of two or three weeks was 300 deg. At 325 deg. the rate of reaction was much greater and at 350 deg. in some experiments the whole of the oxygen disappeared within three or four days, while at 400 deg. the oxidation was always completed in a single day. Hydrogen and oxygen at 350 deg. do not combine to any appreciable extent within a week or two, provided the glass surface with which the gases are in contact remains perfectly smooth. At 400 deg. the formation of water may be recognized within a week, but hardly within three days, whereas at this temperature the whole of the oxygen reacts with methane within a single day. Methane therefore combines with oxygen between 300 deg. and 400 deg. with an enormously greater velocity than does hydrogen under the same conditions. In a later paper Bone[12] says that "under similar conditions ethane burns much more rapidly than methane, and in borosilicate glass bulbs both hydrocarbons are oxidized at temperatures much below the limiting temperature (about 400 deg.) at which, under similar conditions, steam is formed appreciably from electrolytic gas." In a lecture before the Royal Institution Bone[13] showed that when mixtures corresponding to $C_2H_2 + 2H_2 + O_2$ and $C_2H_4 + H_2 + O_2$ are exploded there is no deposition of carbon and only a very slight formation of steam. The hydrocarbon has been burned to carbon monoxide and hydrogen, leaving the hydrogen of the original mixture absolutely untouched by the oxygen.

Experiments on explosions in bombs[14] showed that even at high temperatures there is preferential burning of methane. Bone concludes from experiments with the mixture $CH_4 + 2H_2 + O_2$ that "the ratio of the affinities [really reaction velocities] $CH_4 : H_2$ is of the order 20 or 30 to 1 at least, and probably higher if the influence of the walls of the containing vessel could be eliminated."

From the experiments of Henry, Landolt, and Bone, we see that hydrogen burns before methane at low temperatures in contact with platinum and at high temperatures when the gases are drawn off through a platinum tube. We see also that methane burns before hydrogen at moderate temperatures in borosilicate glass bulbs and also when the gases are fired by an electric spark. It is quite clear that a surface phenomenon is an important factor in changing the results. In Henry's experiments the platinum is unquestionably the cause of the preferential burning of the hydrogen and it seems probable that this is also true for Landolt's experiments. The existence of the water gas equilibrium with hydrogen as one of the constituents is fairly strong evidence that hydrogen is more stable than methane. Bone's results may therefore be considered as approaching at high temperatures the results due to free burning away from a surface. This is the more probable because he always finds a greater relative oxidation of methane in the larger bomb where the ratio of surface to volume is less. The existence of a surface factor is also shown by Bone's observation that about eighty per cent combustion of hydrogen occurs when the mixture $CH_4 + O_2 + 2H_2$ is passed over chamotte[15] at 500 deg. I do not know enough about the adsorbing properties of chamotte to know just why it acts as it does.

Since we can get almost complete preferential burning either of hydrogen or methane at moderate temperatures, depending on the nature of the surface, it is probable that a more extended study of different surfaces would give us all the intermediate values for the distribution of oxygen between methane and hydrogen just as Sabatier and Mailhe[16] have found all sorts of gradations between the reactions $CH_3CH_2OH = C_2H_4 + H_2O$ and $CH_3CH_2OH = CH_3CHO$ and H_2 when alcohol is passed over different heated metals or oxides. While I have not been able to find any definite studies along this line, there are some indications that special results might be obtained with special solids.

Calvert[17] showed that oxygen adsorbed by boxwood charcoal oxidizes ethylene to carbon dioxide and water at ordinary temperatures. This is not surprising because charcoal adsorbs ethylene strongly. Since charcoal has little or no effect in causing hydrogen and oxygen to combine, it is probable that we should get a preferential burning of ethylene in case a mixture of ethylene, hydrogen, and oxygen were brought in contact with charcoal. While this experiment seems not to have been tried, we do know that charcoal does seem to promote oxidation of carbon compounds.

[9] Bunsen: Ges. Abh., 2, 586, (1904).
[10] Phil. Mag., 65, 277 (1825).
[11] Jour. Chem. Soc., 81, 535 (1902) *et seq.*
[12] Jour. Chem. Soc., 85, 694 (1904).
[13] Proc. Roy. Inst., 19, 82 (1908).
[14] Bone: Phil. Trans., 215 A, 298 (1915).
[15] Bone: Ber. deutsch. chem. Ges., 46, 12 (1913).
[16] Ann. Chim. Phys. (8), 20, 341 (1910).
[17] Jour. Chem. Soc., 20, 293 (1867).

In the form of wood ashes, charcoal is often used in outhouses and elsewhere to eliminate unpleasant odors. The charcoal first adsorbs the odoriferous substances and then accelerates their oxidation, by oxygen which is adsorbed from the air. This dual function of the charcoal was pointed out clearly by Stenhouse[18] in 1854.

It is interesting to note that Bone's experiments on surface combustion led him to the conclusion that adsorption played an important part in the phenomenon. Bone[19] began by a study of the combination of hydrogen and oxygen in contact with hot surfaces of porcelain, magnesia, silver, gold, platinum, nickel, calcined spathic iron ore (containing 79.0 per cent ferric oxide and 14.5 per cent manganous oxide), nickelous oxide, and copper oxide. With each of these surfaces the rate is proportional to the pressure of the dry gas when electrolytic gas is used, is approximately proportional to the partial pressure of hydrogen when either gas is present in excess, and is increased by a previous treatment with hydrogen. In the case of porcelain, Bone decides that "porous porcelain occludes or condenses both hydrogen and oxygen at rates which depend to some extent upon the physical condition and past history of the surface. In general, however, whereas in the case of oxygen the process is extremely rapid and the surface layer is soon saturated, the occlusion of hydrogen is slower and the limit of saturation much higher. Combination between the occluded gases occurs at a rate either comparable with, or somewhat faster than, the rate at which the film of occluded oxygen is renewed, but considerably faster than the rate of occlusion of hydrogen."

The behavior of magnesium, "together with the fact that the material occludes hydrogen but not oxygen at red heat, shows that the catalytic action must be referred to the power of occluding hydrogen." The catalytic action of the four metals examined is due primarily "to an association of the surface with hydrogen—in the case of silver probably to the formation of an unstable hydride, in the other three cases to an occlusion of the gas. * * * The evidence in favor of the 'occlusion' theory is particularly strong in the case of nickel, where the 'normal' condition of activity can be reduced almost to the vanishing point by prolonged exhaustion at a comparatively low temperature. Moreover, the subsequent recovery of activity can be demonstrated by circulating successive charges of electrolytic gas over the surface under conditions which entirely preclude any chemical action of either of the reacting gases on the metal." "Considering the results obtained with the three different reducible oxides as a whole, they seem to be quite incompatible with any purely chemical explanation of the catalytic process. In the case of copper oxide it would appear to involve the condensation of a film of 'active' oxygen on the surface, and that this film actually protects the catalyzing oxide from the attacks of the hydrogen, which would otherwise reduce it energetically. At low pressures the film becomes too attenuated to ensure complete protection, and in consequence the formation of steam is accelerated by reason of hydrogen penetrating through onto the oxide and reducing it. In conformity with this idea, the rate of steam formation when the gases are not present in combining ratios was found to be proportional to the partial pressure of the oxygen.

"In the cases of the other reducible oxides examined, the fact that the gases combined at moderate temperatures, without permanently altering the surface, and at rates always far in excess of the rates at which either the surface was reduced by hydrogen, or the reduced surface re-oxidized, does not harmonize with the purely chemical theory.

The fact that the catalytic combustion depends on an intimate contact of the reacting gases with the surface is shown by the appearance of a piece of silver gauze before and after it had acted as catalytic agent for hydrogen and oxygen at 400 deg. The wires were originally very smooth, but after using they became quite rough. Bone[20] points out that at very high temperatures the specific nature of the solid seems to be relatively unimportant. At such temperature one would get practically no displacement of equilibrium by the catalytic agent because the reaction in the gas phase takes place so rapidly that the final equilibrium is that of the gas phase and not that of the catalytic agent.

The general conclusions drawn from this paper are:

1. At low temperatures the nature of the catalytic agent may determine which of two combustible gases will burn the more rapidly.

2. As might be expected, hydrogen burns more readily than methane or ethylene in presence of platinum.

3. From Landolt's experiments the same seems to be true in the flame provided a platinum tube is inserted; but these experiments should be repeated.

4. In presence of copper oxide at 250 deg. all the hydrogen in a mixture of hydrogen and methane can be burned without any methane being decomposed.

5. In presence of chamotte at 500 deg. hydrogen burns much more readily than methane. So little is known about the adsorption by chamotte that this result could not have been predicted.

6. In borosilicate glass bulbs at 300 deg. to 400 deg. methane, ethane, ethylene, and acetylene are oxidized much more rapidly than hydrogen or carbon monoxide.

7. When mixtures of methane, oxygen and hydrogen or carbon monoxide are exploded by an electric spark the methane burns much more rapidly than either the hydrogen or the carbon monoxide.

8. Depending on conditions, either hydrogen or carbon monoxide will burn the more readily.

9. Since charcoal causes ethylene to be oxidized to carbon dioxide and water, and since charcoal has very little effect on a mixture of hydrogen and oxygen, it is probable that charcoal would cause preferential burning of ethylene in a mixture of ethylene and hydrogen.

10. By suitable selection of the catalytic agent it should be possible to get all stages from complete burning of methane to complete burning of hydrogen.

11. Since relatively more methane was burned in the explosion experiments the larger the bomb, it seems probable that methane burns more readily than hydrogen at high temperatures and in the absence of solid catalytic agents.

12. At very high temperatures the specific effect of the solid catalytic agent must become negligible because the reaction will take place so rapidly in the gas phase that the equilibrium reached will be that of the gas phase and not that of the catalytic agent.

Cornell University.

[18] Pharm. Jour., 13, 454 (1854).
[19] Phil. Trans., 206 A, 1 (1906).
[20] Ber. deutsch. chem. Ges., 46, 14 (1913).

Physico-Chemical Properties of Chrome-Nickel Steels

By Herbert J. French

The results recorded in the following sections of these notes are designed to show the properties which may be developed by the heat treatment of certain chrome-nickel steels.

The steels used for these tests have been extensively employed during the past two years for automobile and airplane engine construction. In the writer's experience, which has included the development of the rotary aero engine in this country, these steels cover many of the needs of the manufacturer in such types of construction, where high tensile values together with good ductility are required. The results given will at least serve as a basis of comparison for many similar steels.

Standard tensile test specimens (.505 x 2 in.) were heat-treated in a laboratory electric furnace and the results thus obtained were then checked in actual production by including standard test sections in the ordinary charge for oil fired furnaces.

All temperatures are given in degrees Fahrenheit. The time of treatment of the test bars varied somewhat depending on the initial temperature of the furnace at the time the material was introduced and on the rate at which heat energy was applied. In the main, however, the steel was introduced into a furnace whose temperature was below 400 deg. Fahr. The average time of heating was about 30 minutes, the main idea being to allow the steel to remain in the furnace only long enough to become uniformly heated throughout.

In quenching, care was taken to introduce the steel into the oil as quickly as possible after leaving the furnace. It was then kept in motion in the oil for a period of about one minute. The oil used was Houghton's "No. 2 Soluble Quenching Oil."

The analyses of the steels considered in these notes are given below:

	C.	Mn.	Ni.	Cr.	Grade.
Heat "A"	0.35	0.64	1.47	0.50	Basic open-hearth
Heat "B"	0.43	0.52	1.16	0.72	Basic open-hearth
Heat "C"	0.45	0.51	1.19	0.98	Basic open-hearth
Heat "D"	0.39	0.36	2.56	1.01	Acid open-hearth
Heat "E"	0.24	0.36	3.19	0.98	Acid open-hearth

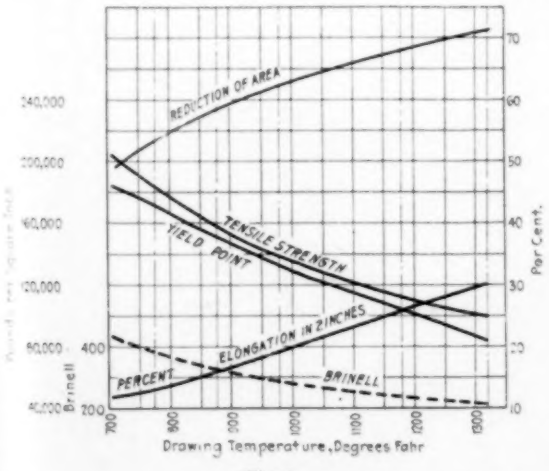


Fig. 1

Open hearth. Forged to about 1 in. round. Oil quenched 1470 deg. Fahr. Drawn as given.

C	0.35	Ni	1.47
Mn	0.64	Cr	0.50
P	0.014	S	0.023

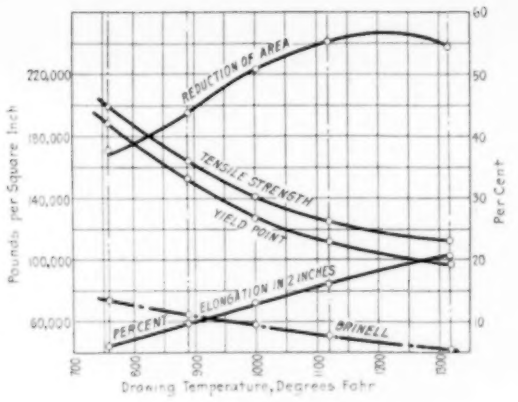


Fig. 2

Open hearth. Forged to about 1 in. round and heat treated. Oil quenched 1475 deg. Fahr. Drawn as given.

C	0.43	Ni	1.16
Mn	0.52	Cr	0.72
P + S	low		

Each of the above heats, made by the open-hearth process have phosphorus and sulphur below 0.04 per cent.

Curves and tables showing the physical characteristics of the various steels for varying heat treatments are given. Photomicrographs are also given for a few of the treated sections.

In the following sections a few results obtained on steels of the type represented by heat "C" are given for heats of varying carbon contents.

The uses to which these steels have been put has varied widely. In the main, the low alloys are to be preferred for forgings when these are to be made at one of the numerous drop forging plants. The chance of receiving material improperly worked under these conditions is greater for the higher alloys and when such a condition exists, only special methods of treatment can bring out the normal characteristics.

Also from the machining standpoint, the low alloy is to be preferred, depending of course, upon the machining operations necessary after forging. However, with careful workmanship and inspection at each stage of the production, all the above steels give very satisfactory results from a manufacturing standpoint.

It is not desired to convey the impression that the quantities measured in the tests recorded below are all that are necessary to determine the best steel for a

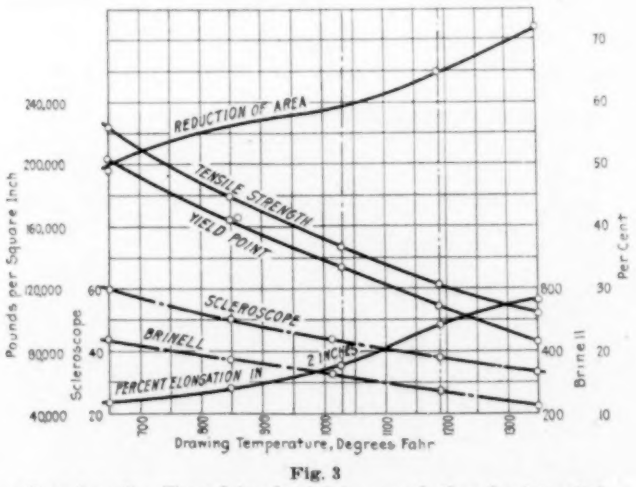


Fig. 3

Open hearth. Forged to about 1 in. round, then heat treated. Oil quenched 1450 deg. Fahr. Drawn as given.

C	0.45	Ni	1.19
Mn	—	Cr	0.98
P	low	S	low

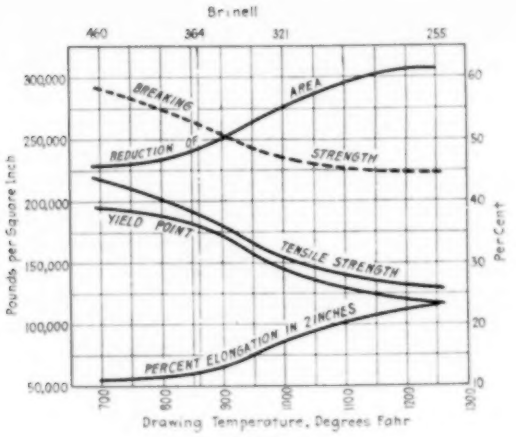


Fig. 4

Acid open hearth. Forged to about 1 in. round. Heat treated. Oil quenched 1475 deg. Fahr. Drawn as given.

C	0.39	Ni	2.56
Mn	0.36	Cr	1.01
P	0.016	S	0.016

given purpose. The results recorded are given so that an idea may be obtained as to what physical properties may be expected from certain commercial steels under tensile test after a given heat treatment has been applied.

In the following tables, yield point has been taken by the drop of the beam of the testing machine. Breaking strength as recorded is taken as the load in pounds recorded on the beam of the testing machine at the point of breaking, divided by the reduced cross sectional area. Brinell hardness numbers are for the standard test, using a 10 mm. ball under a load of 3000 kg.

The tensile test values of Tables 1 and 2, together with the corresponding curves, Figs. 1 and 2, will serve to give a good idea of the physical properties which may be developed by heat treating steels purchased to that standard specification:

	Per Cent.
Carbon	0.35-0.45
Nickel	1.00-1.50
Chromium	0.50-0.75
Manganese	0.50-0.80
Phosphorus, max.	0.04
Sulphur, max.	0.04

These two heats were chosen because they represented very nearly the widest limits of the specification.

Table 1

Heat "A"

Analysis:
Carbon, 0.35.
Manganese, 0.64.
Nickel, 1.47.
Chromium, 0.50.
Hammered to 1 in. round.
Heat treatment: Oil quenched from 1470 deg. Fahr. Drawn as given.
Results plotted in Fig. 1.

Drawing Temperature, Deg. Fahr.	Tensile, Lb. per Sq. In.	Yield Pt., Lb. per Sq. In.	% Elong. in 2 In.	% Red. Area	Brinell	Scleroscope
Drawn at 725	198,600	180,400	12.0	49.8	418	57
Drawn at 780	181,000	171,700	13.0	53.2	381	55
Drawn at 880	161,100	150,300	16.0	58.4	321	50
Drawn at 980	138,600	128,500	19.0	61.7	286	44
Drawn at 1,180	114,800	103,500	25.5	68.2	241	37
Drawn at 1,320	98,400	83,000	30.0	71.3	207	37

Table 2

Heat "B"

Analysis:
Carbon, 0.43.
Manganese, 0.52.
Nickel, 1.16.
Chromium, 0.72.
Hammered to 1 in. round.
Heat treatment: Oil quenched from 1470 deg. Fahr. Drawn as given.
Results plotted in Fig. 2.

Drawing Temperature, Deg. Fahr.	Tensile, Lb. per Sq. In.	Yield Pt., Lb. per Sq. In.	% Elong. in 2 In.	% Red. Area	Brinell	Scleroscope
Drawn at 760	199,750	189,200	11.0	42.8	364	50
Drawn at 880	164,400	153,400	14.5	48.7	321	48
Drawn at 1,000	141,300	126,800	18.0	55.8	286	45
Drawn at 1,120	124,300	111,300	21.0	60.4	255	35
Drawn at 1,320	112,500	96,990	25.5	59.4	207	33

Steel "C," a 1:1 nickel chrome alloy, has been very successfully employed for various purposes. When properly treated it does very well for such parts as crankshafts, connecting rods, valve lifters, etc. The steel works well under the hammer and machines easily. Results obtained on heats of varying carbon contents are given below.

Table 3

Heat "C"

Analysis:
Carbon, 0.45.
Manganese, 0.51
Nickel, 1.19.
Chromium, 0.98.
Hammered to about 12 in. round.
Heat treatment: Oil quenched from 1450 deg. Fahr. Drawn as given.
Results plotted in Fig. 3.

Drawing Temperature, Deg. Fahr.	Tensile, Lb. per Sq. In.	Yield Pt., Lb. per Sq. In.	% Elong. in 2 In.	% Red. Area	Brinell	Scleroscope
Drawn at 650	224,250	202,850	11.75	49.5	444	60
Drawn at 850	179,350	170,000	14.0	56.0	364	47
Drawn at 850	182,500	164,000	15.0	56.0	364	52
Drawn at 1,030	147,750	131,950	16.0	59.0	321	44
Drawn at 1,030	144,500	134,800	17.5	58.8	321	42
Drawn at 1,190	122,200	108,200	24.0	65.0	269	37
Drawn at 1,350	103,700	85,400	28.0	72.5	217	32
Annealed 1,450	93,800	58,600	25.5	62.0	187	25
As forged	109,470	73,480	22.0	68.0	187	29

Analysis:
Carbon, 0.22.
Nickel, 1.09.
Chromium, 0.95.
Phosphorus, 0.022.
Sulphur, 0.014.
Hammered to about 12 in. round.
Heat treatment: Oil quenched from 1550 deg. Fahr. Drawn as given.

Deg. Fahr.	Tensile, Lb. per Sp. In.	Yield Pt., Lb. per Sq. In.	% Elong. in 2 in.	% Reduct.	Brinell
Drawn at 425	243,500	.....	11.0	43.6	555
Drawn at 650	215,500	.....	13.5	49.5	430
Drawn at 800	197,200	181,000	12.0	55.0	415
Drawn at 800	194,000	177,150	12.0	59.8	387

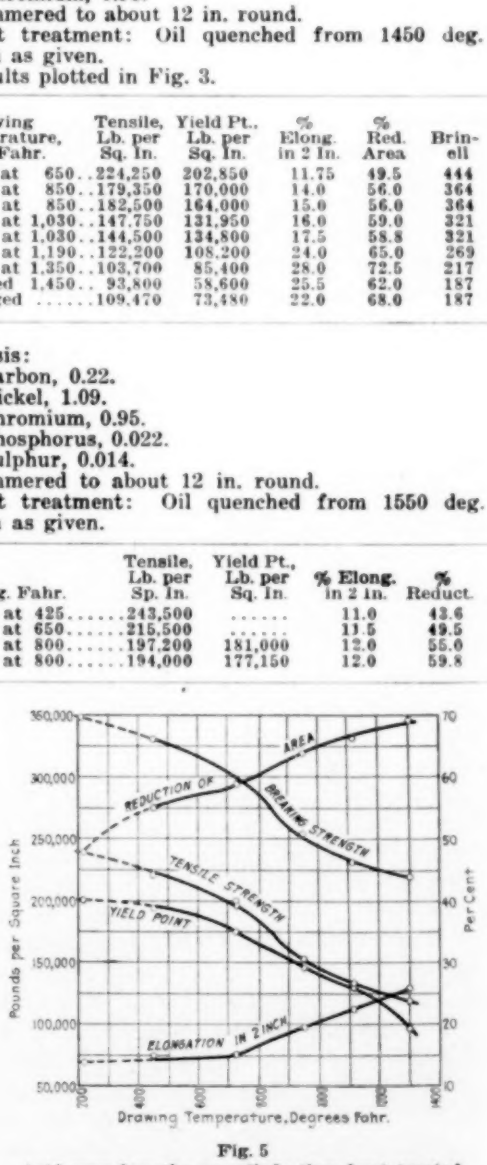


Fig. 5

Acid open hearth: as rolled: then heat treated. Oil quenched from 1475 deg. Fahr. Drawn as given

C	0.24	Ni	3.19
Mn	0.36	Cr	0.98
P	0.015	S	0.017

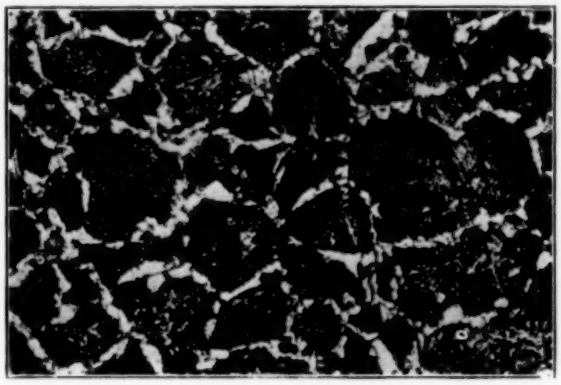


Fig. 6

C, 0.39; NI, 2.56; CR, 1.01. VERY MUCH OVERHEATED STEEL. COOLED IN FURNACE FROM 2000 DEG. FAHR. 100 MAGNIFICATION. ETCHED NITRIC ACID

Analysis:
Carbon, 0.61.
Nickel, 1.24.
Chromium, 1.11.
Hammered to about 1 in. round.
Heat treatment: Oil quenched from 1525 deg. Fahr. Drawn as given.

Deg. Fahr.	Tensile, Lb. per Sp. In.	Yield Pt., Lb. per Sq. In.	% Elong. in 2 In.	% Reduct.	Brinell
Drawn at 680	221,650	198,500	13.0	54.0	415
Drawn at 850	184,500	169,500	15.5	50.0	364
Drawn at 1,030	148,000	136,300	20.0	60.0	302

Table 4
Heat "D"

Analysis:
Carbon, 0.39.
Manganese, 0.31.
Nickel, 2.56.
Chromium, 1.01.
Phosphorus, 0.016.
Sulphur, 0.016.
Hammered to about 12 in. round.
Heat treatment: Oil quenched from 1450 deg. Fahr. Drawn as given.
Results plotted in Fig. 4.

Drawing Temperature, Deg. Fahr.	Break. Str., Lb. per Sq. In.	Tensile, Lb. per Sq. In.	Yield Pt., Lb. per Sq. In.	% Elong. in 2 In.	% Red. Area	Brinell
700	291,300	217,000	194,400	11.25	45.7	460
860	262,500	188,700	178,200	12.0	48.3	364
1,000	234,600	154,150	145,550	17.0	52.7	321
1,000	233,100	148,150	138,900	17.5	54.9	321
1,250	223,700	127,850	117,000	23.0	61.3	255

Fig. 6 is a micrograph of this steel, very much overheated, and cooled in the furnace from 2000 deg. Fahr. Fig. 7 represents the approximate condition of the steel represented by the third line of the above Table 4.

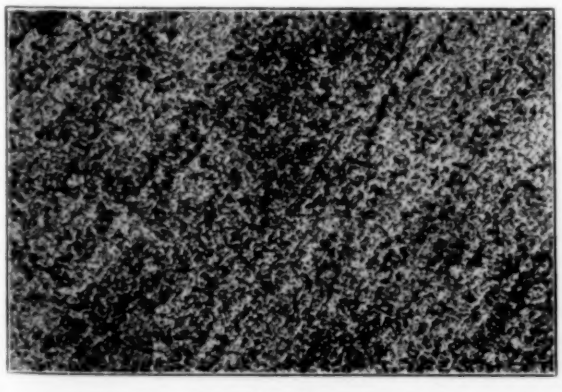


Fig. 7

C, 0.39; NI, 2.56; CR, 1.01. OIL-QUENCHED FROM 1475 DEG. FAHR. DRAWN AT 1000 DEG. FAHR. 100 MAGNIFICATION. ETCHED WITH NITRIC ACID

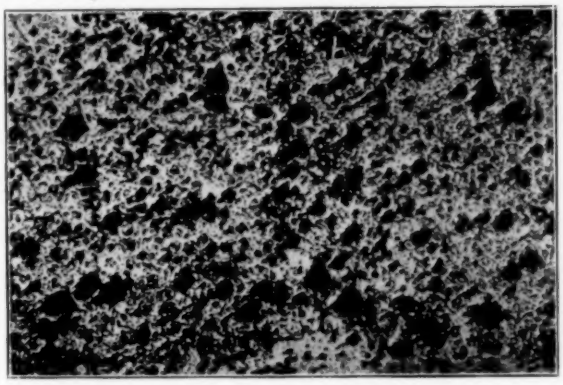


Fig. 8

C, 0.24; NI, 3.19; CR, 0.98. OIL-QUENCHED FROM 1475 DEG. FAHR. DRAWN AT 450 DEG. FAHR. TENSILE STRENGTH, 220,750; YIELDING POINT, 192,650; PER CENT ELONGATION IN 2 IN., 15.0; PER CENT REDUCTION OF AREA, 55.15. 100 MAGNIFICATION. ETCHED WITH NITRIC ACID

Table 5
Heat "E"

Analysis:
Carbon, 0.24.
Nickel, 3.19.
Chromium, 1.01-0.98.
Phosphorus, 0.028.
Sulphur, 0.016
Manganese, 0.36.
As rolled: Machined to standard test specimen.
Heat treatment: Oil quenched from 1475 deg. Fahr. Drawn as given.
Results plotted in Fig. 5.

Drawing Temperature, Deg. Fahr.	Break. Str., Lb. per Sq. In.	Tensile, Lb. per Sq. In.	Yield Pt., Lb. per Sq. In.	% Elong. in 2 In.	% Red. Area	Brinell
212	347,300	237,350	201,300	14.0	47.7	477
450	330,200	220,750	192,650	15.0	55.15	444
725	298,000	199,200	192,950	15.0	59.05	387
725	.....	195,850	179,000	14.75	58.5	387
950	253,700	152,250	144,100	19.5	64.2	321
1,110	232,200	133,750	129,000	22.25	66.3	286
1,300	221,900	118,450	94,650	26.0	68.8	248

The microscopic structure of the steel approximately as shown in the second line of the above Table 5 is given in Fig. 8; of the fourth line in Fig. 9; and of the last line in Fig. 10.

With the above data at hand, a short discussion of the application of these steels and difficulties encountered in their use is given below.

The steels represented by the above five types have been used in connection with the development of the

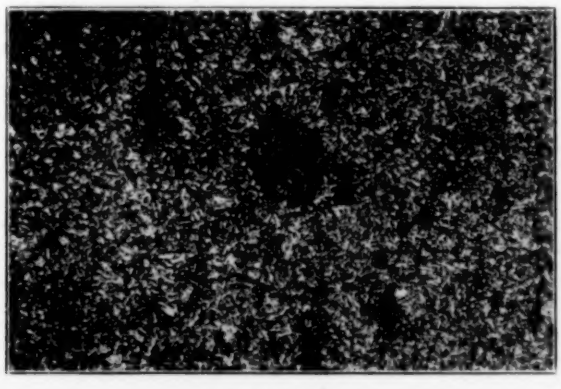


Fig. 9

C, 0.24; NI, 3.19; CR, 0.98. OIL-QUENCHED FROM 1450 DEG. FAHR. DRAWN AT 750 DEG. FAHR. 100 MAGNIFICATION. ETCHED WITH NITRIC ACID

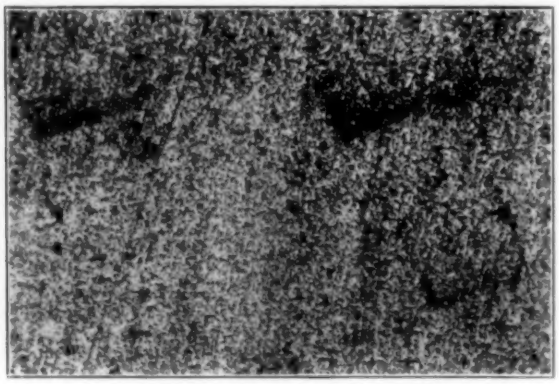


Fig. 10

C, 0.24; NI, 3.19; CR, 0.98. OIL-QUENCHED FROM 1450 DEG. FAHR. DRAWN AT 1300 DEG. FAHR. 100 MAGNIFICATION. ETCHED WITH NITRIC ACID

Gnome type airplane engine in the United States.

These types of steels are also excellently suited for automobile work. Suitably heat treated, they have been used for the axles of small electric vehicles and for engine parts and transmission of gasoline trucks and pleasure cars. Particularly heats "B," "C," and "D" are to be noted. These steels, used for crankshafts, connecting rods, etc., have proven very satisfactory when properly fabricated and heat treated.

As mentioned previously, a steel similar to heat "D" is very susceptible to improper working under the hammer. The following remarks applying to this alloy, apply equally well to a lesser degree to the lower alloys. In other words, the lower chrome-nickel steels will stand more abuse in fabrication, and will under these conditions show the effects of the improper working to a less marked degree. Too rapid heating and especially heating in an open fire which leaves the center of the mass of metal "cold" and the outside "dripping," is to be avoided.

One of the most flagrant violations of the principles of metallurgy, came to the writer's notice some time ago in connection with this type "D" steel, of slightly higher carbon content. In reducing small electric furnace ingots to the proper sized billets for drop-forging, one shop subjected this steel to an open coke fire, causing an intense and localized heating of the end of the ingot, leaving a large portion and the center "cold." When reduced to the proper size under the hammer, the steel was absolutely worthless. However, more often the effect of cold working is less serious as when the whole mass of steel, uniformly heated, is hammered at too low a temperature. This condition of strain can be obliterated if proper heat treatment methods are employed. Long heating at rather high temperatures are often necessary which slows up and increases the cost of production.

The fact that under these circumstances the outside portion of the mass is burned aggravates the situation. Also, ordinary annealing may soften the steel so that a hardness test will show nearly normal results, but machining will still be difficult.

The same thermal principles entailed in the discussion above apply equally well to the heat treatment processes proper. Slow and uniform heating is essential for good results. Accurate temperature control and intelligent furnace operation are also necessary.

Chemistry and the Banker

Two very interesting and important addresses were delivered at the Chemical Exposition on Friday evening, Sept. 28, at a meeting of the New York Section of the American Chemical Society. The subject of the evening was "The Chemist and the Banker," and in view of its great importance and the need of closer relations between the two, we publish both addresses here in full. The chemists' side of the question was ably discussed by Dr. A. D. Little of A. D. Little, Inc., Boston, Mass., and the bankers' side by Mr. G. A. O'Reilly of the Irving National Bank of New York.

The Chemist

BY ARTHUR D. LITTLE

Most chemists know perfectly well what a bank is. It is an institution for minimizing the wear on paper money and is generally located in the best looking building in town. It works this way. You take your salary check to the bank before two o'clock and give it to a man in a cage whom you don't know. He writes $1,000 or may be only $65, in the little book you bring and you can then spend your salary without soiling a dollar of real money by simply writing other checks. Once in a great while, to hold your custom, this man writes in "interest 18 cents" in the little book and you spend Sunday in trying to find the error. Then the bank lends part of your salary to the United States Government for which it gets 2 per cent gold bonds against which it issues bank notes to enable it to pay rent and salaries, and it lends the rest of your check to railroads and manufacturing corporations and to farmers to move the crops. Its profit is the difference between the interest they pay and the 18 cents the bank pays you, as pointed out by Stanley Jevous in "Money and the Mechanism of Exchange."

Now the chemist goes at least once a month to the banker's bank whereas the banker seldom or never comes to the chemists' laboratory. It is not surprising therefore that the banker rarely acquires an equally clean-cut understanding of the relation of chemistry to the salary check he draws. To-night, with this great Exposition for our background, it is our privilege to enlighten him and I will ask the bankers present to kindly move into the front seats, without crowding.

Chemistry deals with the properties of matter and the changes which they undergo. Banking deals with the properties of money and the changes which they undergo. Money is merely a special form of matter set apart by agreement to facilitate the exchange of other forms of matter. The conclusion seems inevitable that banking is merely a department of chemistry like metallurgy or paper making.

The authenticity and fineness of the gold coin which constitutes the monetary basis is determined by chemistry. The mint is a chemical plant. Southern chemists get the best results from it.

It is chemistry rather than mining which is ultimately responsible for the amount of gold produced. The chlorination process and the cyanide process by rendering profitable the treatment of vast quantities of low grade ores profoundly affected the value of every ounce of gold in Christendom and the exchange value of all securities and commodities. But gold and the currency based thereon are only the exponents of indi-

vidual and national wealth. The commanding influence of chemistry becomes most apparent as we consider the true wealth of nations: the things which money and securities merely represent.

There is an unfortunate tendency among financial men to regard as chemical only those activities which have to do with the production of alkali and acids, dyes, explosives, synthetic drugs, and analogous materials within a narrowly limited field whereas there is hardly any industrial activity which does not from some point of view present a clearly defined chemical aspect. Agriculture thus becomes a department of photo-chemistry and the production of indigo by the plant under the influence of sunlight is no less a chemical process than its synthesis in a factory. When, however, that synthesis was accomplished in the laboratory, wise bankers began to scrutinize the credit of indigo planters.

Our national wealth is largely founded upon agriculture. Bankers annually bestir themselves to move the crops. There would be far less to move were it not for chemical fertilizers, chemical sprays to keep down the ravages of insects, and bisulphide of carbon which saved the wine industry of France and to which the American farmer is scarcely less indebted. By its utilization of the cotton seed, chemistry had added before the war at least $200,000,000 annually to the value of the cotton crop and the war itself is being fought with explosives made with cotton linters. Cotton is no longer merely a textile fiber. It is the raw material for great chemical industries, for the production of moving picture films, artificial leather, artificial silk, the endless varieties of celluloid, lacquers, aeroplane varnishes, dopes for patent leather and reinforced glass. Corn is still primarily a food crop but it has become much more. Chemistry has made it yield oil, dextrine, glucose, starches, and adhesives in great variety, thus bringing new grist to the banker's mill.

In every state and most conspicuously in Washington, chemical laboratories supported by the public funds attest the dependence of agriculture upon chemistry, which science thus becomes the fountain head of this great source of national wealth.

The securities based on steel production loom large before the banker but are rarely credited by him to chemistry. Yet making steel or aluminium, or extracting and refining copper and nickel, are as definitely chemical operations as making coal tar dyes. So with manufactures of the most diverse sorts, the tanning of leather, making bread, bricks, cement, lime, paper, coke, carbide, glass.

But wealth to be available for exchange must for the most part be transported and to facilitate such transportation great financial structures have been built up by bankers. Of these structures or the properties they represent chemistry is again the cornerstone. Who would build railroads or dig canals without Portland cement and dynamite, steel rails and bridge members? The Bessemer process alone, and chiefly because of its influence on transportation, was claimed by Abram S. Hewitt to add $2,000,000,000 yearly to the world's wealth.

A volume of fascinating interest could be written on the influence of chemistry upon the wealth of nations. The discovery of sulphuric acid caused wealth to flow in a broad stream to Sicily and the substitution of pyrites for sulphur threatened the island with bankruptcy. Not gold, but the cyanide process for extracting gold, established the prosperity of South Africa. The nitrate beds of Chile and the potash mines of Germany constitute national assets of the first importance because chemistry synthetized their values as it now in nitrogen fixation plants synthesizes wealth from air.

Although the chemist is still often made to feel that he is speaking a foreign language when talking to a banker, the events of the last three years have stimulated a rapidly growing appreciation in the minds of men of affairs and financiers of the fundamental importance of chemistry as a factor in national development and the basis of prosperity.

The time has come for chemists and bankers to find a common language and to establish a mutual understanding. The bankers need not prove that they can help the chemists, we admit it. We are not sure that they realize the extent to which we can help them.

Some bankers are finding it worth while to study Spanish because it leads them into a new financial world. It is in the power of chemistry to open up a new universe of finance.

Dewar has said that the whole object of the training of a chemist is to produce an attitude of mind. For what do men in hundreds daily risk their lives in aeroplanes over the battlefronts of Europe? They do it simply to get a new point of view from which the enterprise of armies may be directed by their commanders. Is it not then wise for the financiers who are the generals of industry to utilize to the utmost the scientific imagination, which is only logic in flight.

With due mental reservation for a few conspicuous exceptions, it may be said without much fear of contradiction that bankers generally seem to chemists to lack imagination and to experience a surprising difficulty in visualizing an unfamiliar situation. For instance, it hurts a chemist to see great quantities of raw material going to waste. It doesn't seem to hurt a banker very much. A chemist views with his mind's eye the vast potential wealth awaiting development by chemical methods, in the gas, oil, salt, sulphur and wood waste focussed in Louisiana. Frequent reference to it fails to arouse the enthusiasm of the banker, and very little happens. Evidently the chemist has not learned the proper formula for presentation of such large affairs.

In financing a cotton mill it is, I am told, possible to estimate the cost within a few cents per spindle. No such accuracy can be expected in case of a chemical plant, and particularly generous allowances must always be made where new processes are involved. Chemical investments in their early stages are undoubtedly speculative, and often highly so in character, but the speculative feature stands commonly in an inverse ratio to the amount of capital available for development. Important chemical enterprises should be initiated only by men with large reserves of capital and who wear thick woolen socks. Widows and orphans and small investors should keep away from them. Unless you can stay in it to the finish it is dangerous to get into a good thing too soon. By way of example: the first three companies organized by Count du Chardonnet for the manufacture of artificial silk, failed; stock in the fourth sold at $2,280. One can, on the other hand, point to highly successful chemical enterprises which have been established on an initial capital of $50,000

or less. What is particularly needed is a more direct approach to capital by chemists, through chemists.

In their contact with existing industries, banks are beginning to recognize that it is sometimes better policy to call upon a chemical engineer to set a business straight than it is to foreclose a mortgage. They do not always seem to appreciate, however, the extent to which the adequacy or the lack of chemical control of material and processes may affect the desirability of credit lines. A balance sheet does not always show where the dollars go in business. Many of them may be going up the chimney or down the stream, or into the slag pile. Many may disappear in low yields or products classed as seconds. A chemical audit of a plant is sometimes more informing than a balance sheet. Bankers, all the world over, are straining their energies to aid their governments in placing gigantic war loans. How shall these staggering burdens be carried and the obligations ultimately paid? The chemists' answer is: by conserving the values we already possess; by converting into actual wealth the vast potential values in raw materials now wasted; and by developing the estate.

If New England farmers cannot raise sheep because of vagrant dogs, let us intern those dogs. Since labor is scarce let us stop the nonsense I have just seen perpetrated by digging one trench instead of four to connect public services with a new building. Let us see if the simple expedient of making it difficult to insure flimsy construction and bad risks will not cut something substantial from our annual fire loss of $200,000,000. Through long years of peace and plenty dwellers in American cities have carried a heavy burden of municipal extravagance and inefficiency. Now is the time for us to realize that every dollar so wasted is a dollar filched from the fund for national defense. Equally serious to the nation and closer to the individual are the losses from preventable ill health. There are the yearly losses, amounting into billions from bad agriculture, bad packing, bad distributing systems, and the absence of dehydrating plants.

The suppression of these especially discreditable forms of national extravagance concerns banker and chemist and all good citizens. There are other colossal wastes which more directly concern the chemist in his professional capacity and the banker as a financial agent, wastes of coal and natural gas and yellow pine and cereal straw in amounts running into figures which sound like stellar distances and which seem to make about the same impression on the average mind. Suppose Niagara Falls ran coal instead of water, how long would we burn the coal at the base of the falls to make a spectacle and remain easy in our consciences?

The losses due to inefficient manufacturing, though indeterminate, are far greater than either bankers or manufacturers realize. They are in large measure subject to chemical control, and when thus minimized have often spelled the difference between disaster and dividends.

Suppression of the waste thus far enumerated would pay our war expenditures within five years, and thereafter make our country the financial reservoir of the world.

It is finally the mutual duty and opportunity of the banker and the chemist to co-operate in the development of the estate which is our country. To a similar end England has mobilized her scientists and made grants of over a million pounds to promote industrial research. Her manufacturers are organizing research associations to co-operate with the Government and divide the financial burden pound for pound. While the resources of our own country offer literally boundless opportunity for profitable research, we have still to utilize many research results of large importance which are immediately available.

To this extent the chemist, with his proofs in hand, now waits upon the banker.

* * * *

The Banker

BY G. A. O'REILLY

Under ordinary conditions and in normal times the spectacle of a banker presuming to address a body of chemists upon their exclusive and somewhat mysterious specialty, or indeed upon any other subject closely related to this specialty, would be rather unusual, perhaps a bit amusing, and certainly would suggest a quality of nerve which quite consistently and even profitably might be applied to some more heroic, although probably not more difficult, task.

Just where the theories of banking and the practice of chemistry come together is a subject which, it is feared, in the past, has not claimed the attention of banking circles to the extent to which its merit would appear to entitle it.

However, the conditions under which we meet are not ordinary conditions, and the times in which we live are not in the least normal times. Conditions are far from ordinary when throughout the world men may look out upon a situation strewn with the wrecks of institutions upon which men had learned to depend for safety and security and guidance, and where, as affecting the relations between men, race and creed and kin, have lost their meaning; and times are far from normal when, after a thousand years and more of Christian teaching and thought and inspiration, Christian men consistently may speak of saving the spirit of the world from the savage ferocity of Christian nations, and when each thought carries with it the shadow of a fear.

And so the task which, under other conditions, would be so difficult of treatment, becomes easy and alive and tangible because in it is found a wonderful possibility of treating some of the wonderful big things which have come into this new war-born field of national thought in which new institutions of the future must be created to take the place of those we have seen so ruthlessly destroyed.

These are wonderful days in which we live. Upon every hand are striking and unmistakable object lessons to point the way for us and to guide national thought and impulse. Recently it was my privilege to attend the deliberations of three of the country's great business conventions—the National Petroleum Association, the War Congress of American Business, under the auspices of the Chamber of Commerce of the United States, and the American Bankers' Association, all at Atlantic City and all held in rapid succession.

Under any conditions these would have been unusual gatherings; held as they were, at this time, and under the stress of war conditions, their normal importance

was vastly increased. Many interesting subjects were discussed and in masterly manner. Widely separated points of view and almost every possible shade of national business interest were represented.

Understand, they were not war conventions, nor were they characterized by any of the fervid war utterances with which the country was filled only a few weeks ago, and still, whatever the subject and however its treatment was begun, the discussion inevitably found itself moving along war channels, and the conclusions reached invariably were based upon war considerations.

Another striking characteristic of these conventions was found in the highly constructive quality of their deliberations. No time was wasted upon appeals to the patriotism of our people, or to their fighting spirit. The spectacular aspect of war nowhere was in evidence. The atrocities which the enemy is perpetrating under the guise of war received hardly a passing glance. No attempt was made to explain our presence or motives in the war, and above all there was no note of doubt or uncertainty as to either the seriousness of the war or its intimate relation to our national life.

It was as though the diverse and conflicting business interests of the nation, at last and in obedience to some unexpressed impulse which dominated the entire situation, had found a motive so big and so truly national that in its presence the sectional and personal quibblings of times of peace and security were unable to live.

The spirit of it was altogether splendid, and the lesson it taught full of inspiration. If such a spirit can be applied to a purpose like ours here to-night, the solution of our rather unusual problem, the determination of the proper relationship between even so divergent elements as chemistry and banking, should be easy—otherwise our time will be wasted, our effort fruitless, and discussions instead of bringing our respective specialties and viewpoints more closely together will only intensify the difference between them, and hence drive them farther apart.

The true relation of banking to chemistry is to be found only in the very simple and easily understood theory of practical business. The situation is not difficult unless we are unreasonably disposed to make it so. If the banker can relieve his function of the oppressive weight of self-constituted and unjustified importance under which it has struggled in the past, and bring it out into the open, and give it the sort of contact with other business institutions it needs and deserves, and if the chemist can emerge from the somewhat mysterious atmosphere with which unfortunately, through his fault or otherwise, he and his function have been enshrouded, and give the average business man a chance to realize how tangible and how intensely practical a business institution chemistry really is, the solution of the problem which forms the basis of discussion to-night will be found in the practical working out of the business transactions of every day.

Of course, to the banker or to any other layman, chemistry is difficult and mysterious and, until he is properly informed, rather apart from the business things of every day. But a little broadening of our general attitude toward the other man's specialty, a little fuller development of our powers of observation as we move through the business walks of life, and a little greater effort on our part to discover true relationships between apparently unrelated things will do wonders toward creating in us a respect for the intensely practical business possibilities for us which exist in the subject of chemistry.

In this direction Europe has gone much further than we. A few years ago I had occasion to make a rather thoroughly study of the co-operative institutions of Europe. Those of Denmark were found to be particularly interesting because of their high condition of development, and because of the extent to which the practical spirit of co-operation dominated the entire situation. The people of the country did not do much talking about getting together—they got together.

This wonderful little population of less than three and a half million people, able in normal times to sell annually in London alone more than $150,000,000 worth of bacon, butter and eggs, and practically to dominate that city's market in these lines, has not failed to give the chemist his proper place in the nation's economic plan, nor have they failed to utilize his equipment and services effectively in connection with the simple business details of every day.

To them the chemical laboratory is not, as unfortunately it appears to be with us, a rather remote institution to be resorted to only when normal methods of treatment fail to work, but rather an institution which is fundamental in even their simplest processes.

As a result of intelligent investigation and analysis, the farmer knows his different soils as he knows his friends, and treats them with what impressed me as rather greater consideration. If one of his crops is not performing up to the rather arbitrary standard decided upon by the co-operative agricultural society of which he is a member, his attention is directed to that fact by the society and the situation immediately is made the subject of investigation and treatment by the scientific establishment which is a serious part of the equipment of every well regulated Danish organization of this class.

If the milk product which he delivers to his co-operative dairy is deficient in some important element, the matter comes to his attention at once. The formula upon which he has been feeding his cows is inspected and, if necessary, a change is made to suit the requirements of the particular case.

If the eggs which he delivers to his co-operative egg export society are not up to a proper standard, his hens, their housing, diet and treatment immediately are made the subject of investigation, and again the remedy applied in whatever form is deemed most desirable, not by the farmer himself but by the scientific institution which speaks for the larger united interest of which the farmer is a part.

It is interesting too to learn that this service comes to the farmer not in a special or unusual way, but as one of the commonest details in the management of his farm, and practically without extra expense to him.

In the Philippine Islands a few years ago an effort was made, and with only modified success, to manufacture and introduce into the United States a ladies' summer hat made of the bamboo fiber. This is one of the most beautiful hard fibers in existence. It possesses every quality which reasonably could be demanded by the millinery trade, for a reasonably cheap, light, wide-

brimmed hat of fine finish and pleasing appearance. The bamboo is found in unlimited quantities in the Philippines, and the people are so expert in its treatment that a reasonably high-grade hat could be produced for not to exceed 50 or 60 cents. Such a hat, if it happened to be agreeable to the requirements of the American trade, should retail in the United States for from $3 or $4 upward.

At just about the time when this bamboo hat was beginning to promise commercial success in the United States there was developed a demand for hats in colors. The Philippine hat situation, because it lacked facilities for the proper treatment of bamboo fiber with color, was entirely unable to respond. It happened that there was not in the islands a color chemist. Experiments performed in the Government Bureau of Science and by private concerns were not satisfactory in their results. It was easy enough to color the fiber, but to treat it with fast colors and without dulling the very desirable bamboo surface was found to be entirely beyond the equipment of the local situation.

As a result, this hat, basically probably the best in the world of its general class, is practically unknown in the United States, and the Philippine Islands have lost a commercial product which if properly developed would represent at least half a million dollars per year.

I find the chemists' side of this evening's subject, which has been assigned to Dr. Little, and, as described by a Chinese cook I once had as "no b'long my pidgin," to be so exceedingly attractive that it requires an effort on my part to keep off the grass and talk about my own subject—the banker.

The other day I heard a man, a banker, say that banking was unfortunate in that it was parasitic—that it lived upon the lives of others and created nothing of its own. Of course he was wrong—altogether so—but, unfortunately, his remark only reflected an all too common estimate of the profession and an estimate for the existence of which bankers themselves are not a little to blame.

There is nothing in the nature of the bank, unless, perhaps, it be the banker, which should conduce to the creation of such an impression. If logically founded, properly equipped and intelligently directed, it can perform a business function in which the creative element figures as prominently as in production or manufacture or distribution.

The producer creates by transforming the riches of the earth into tangible and usable value, which he disposes of to his advantage. The manufacturer creates by changing the form and increasing the usefulness, and incidentally the value of the product, which he in turn disposes of, and to his advantage. The wholesaler and the retailer, without any essential change in the form of what comes from the manufacturer or the producer, sells the product, probably to a greater personal advantage than either of the others.

The banker, in a spirit differing in no essential from that which actuates the producer, the manufacturer, the wholesaler and the retailer, comes into these processes of production, treatment and distribution even more frequently and certainly not less importantly than any of the others. Indeed, we might say that his is the most important function of all in the carrying on of these processes.

The bank makes it possible for the farmer, the miner, the lumber man so to conduct their producing activities that if they proceed intelligently and consistently they always can find the financial means whereby operations may be continued and properly extended. In even a greater degree the manufacturer, the wholesaler and the retailer have learned to depend upon the bank for assistance. The treatment of commercial paper, whereby the immense commercial credit of the country may be utilized, transactions in connection with foreign trade, the conservation and investment of funds, the treatment of stocks, bonds and securities—all are functions performed by the bank and recognized by business men of all classes as vitally important in the nation's commercial life.

I have said that the true relation of banking to chemistry is found in the theory of practical every-day business. This theory must be taken seriously and literally by both banker and chemist if they are to derive the greatest benefit from each other and from business. Regardless of tradition and of possible personal inclination, they must descend from their respective pinnacles, whether of financial exclusiveness or scientific preoccupation, and get together in the intensely practical and really very comfortable atmosphere which the thoroughly up-to-date business man of to-day has created and prepared for them. If in doing this it becomes necessary to disturb an occasional delightful fiction, or to smash an occasional professional idol, it is believed that both may be done to the entire benefit of all concerned.

Just how much of a transformation in the chemist and in chemical industries must take place in order to produce the desired result, the chemist knows better than I. In any event, a substantial movement in the right direction has been made. A few expositions like this, and the conspicuous service which chemistry has rendered to business in recent years will leave no room for doubt as to the final outcome.

With the banker, too, the case seems exceedingly hopeful. Tendencies like those developed during the recent convention of the American Bankers' Association at Atlantic City indicate not only full realization, but also a large measure of practical assumption of the bank's responsibilities in the active business situation.

The banker of to-day—or rather of to-morrow—because it is with him that we are concerned, as the world does move, must be, first of all, a business man. He must be able to get away from the fictions of former years, in which the banker, because of his intimate association with money, became obsessed with the idea that he and money were of the very essence of each other and that they mutually reflected each other's virtues for the general edification of mankind. He must be able to speak the language of business, to meet the business man upon business grounds, to discuss with him business problems, and, by his ability to provide the remedy required, must even prove himself to be the better business man of the two.

He must realize that in the larger sense the bank must depend upon business and not business upon the bank—that in the great mass of institutions indispensably connected with business activities the bank is only one, and not by any means the most important one.

This banker of the future must enter into the business life of the community more extensively and more

actively than in the past. He must so equip himself and his institution as to be fully prepared to perform whatever function may be submitted to him by the business of the situation of which he is a part. Upon business questions which come to him for treatment, his function must be that of a specialist—a sort of physician for the treatment of ills which affect the life of business.

It may seem that this is an unreasonably high standard of business excellence to be required of a man already deeply immersed in the purely financial details of his institution, but the developments of modern business leave no doubt as to the nature of its requirements upon him. The pace which he must observe is being set for him without any particular reference to his inclinations or to the business habits which he may have formed. The developments of modern business demand certain classes of banking service, and also demand that in providing this service the bank perform up to a certain standard of excellence.

Naturally, a discussion at the present time upon two such nationally important subjects as chemistry and banking, particularly in relation with business, would include consideration of the greatest business enterprise in which this or any other nation ever has taken part—the war.

The theory that the true relation between chemistry and banking is found in business finds considerable justification even in conditions existing before the war. When viewed in the light of the big, wonderful new things which war has brought into the world, the conclusion becomes irresistible. The indifference with which in former years private interest viewed national problems and difficulties finds but slight resemblance in the magnificent response which business everywhere has made to the nation's call.

And so, while in considering the business relationship between chemistry and banking we should concede sufficiently to the business advantages which will result to both from a proper getting-together, we must not lose sight of the fact that the big thing in this relationship will be the national interest. For us there are just two worth-while things in the world to-day—one, to win the war; the other, to protect American interests afterward. Naturally, winning the war comes first, but preparations to that end should be definitely based upon the understanding that wars are to be won principally that nations may live in greater peace and security.

We must realize that the friendships and alliances of war need not control the international relations of the future. We must not forget that the ancient struggle for commercial mastery of the world is based upon conditions which will exist until the end of time, and that this struggle will be taken up again upon the day when peace is declared, not less strenuously than before, and that in it we must be prepared to protect our own interests in peace no less seriously than we now protect them in war.

Increased Exports of Manufactures.—According to a statement issued by the Bureau of Foreign and Domestic Commerce, 78 per cent of the more than six billion dollars worth of American goods exported during the year ending June 30, 1917, consisted of wholly or partly manufactured goods. Chemicals, dyes, etc., amounted to 182,040,380 as compared with $22,714,611 in the year ending June, 1914.

Storage, Weathering and Spontaneous Combustion of Coal

A committee of the National Electric Light Association has collected much data in connection with the problem of storing coal and finds that the literature on this subject is voluminous and also contradictory.

The matters to be considered in connection with storage and which have to be given due weight by the purchaser involve the question of losses due to weathering and those due to spontaneous ignition.

WEATHERING

The weathering of coal is a question on which much difference of opinion exists. There have been statements made to the effect that all bituminous coals lose in calorific values largely and continuously. This point of view has not been confirmed by investigators who have made extensive studies of the problem. To dispose of this feature, the following quotations from the publications of the Bureau of Mines and the University of Illinois Experiment Station can safely be accepted as authoritative and conclusive.

TABLE I

CALORIFIC VALUE (IN GRAM CALORIES) OF THE COAL SUBSTANCE (MOISTURE, ASH, AND SULPHUR FREE COAL) BEFORE AND AFTER STORAGE

Kind of Coal	Storage Conditions.	Place	Calorific Value				Percentage of Loss in 2 Years
			As Stored	After 3 Months	After 1 Year	After 2 Years	
New River, W. Va.	¼-inch coal, under sea water.	Portsmouth, N. H.	8761	.....	8759	8730	[b]0.39
		Norfolk, Va.	8754	.....	8763	8737	[b].40
		Key West, Fla.	8747	.....	8732	8770	0
	¼-inch coal, under fresh water.	Pittsburgh, Pa.	8752	8762	8749	8760	0
	¼-inch coal, exposed to air indoors.	Portsmouth, N. H.	8779	8738	8742	8709	.80
		Norfolk, Va.	8751	8742	8736	8717	.39
		Key West, Fla.	8754	8728	8676	.....	.....
		Pittsburgh, Pa.	8769	8736	8719	8720	.56
	R. O.M. coal exposed to air indoors.	Portsmouth, N. H.	8754	8758	8748	8734	.23
		Norfolk, Va.	8743	8764	8725	8725	.21
		Key West, Fla.	8745	8733	8710	.....	.....
		Pittsburgh, Pa.	8753	8758	8740	8743	.11
	¼-inch coal, exposed to air outdoors, uncovered.	Portsmouth, N. H.	8741	8730	8701	8674	.77
		Norfolk, Va.	8726	8709	8666	8625	1.16
		Key West, Fla.	8739	8721	8680	8592	1.85
		Pittsburgh, Pa.	8763	8726	8700	8665	1.12
	R. O.M. coal exposed to air outdoors, uncovered.	Portsmouth, N. H.	8775	8766	8760	8722	.60
		Norfolk, Va.	8743	8745	8720	8695	.55
		Key West, Fla.	8762	8708	8722	8632	1.29
		Pittsburgh, Pa.	8752	8740	8716	8696	.64
Pocahontas, Va.	120-ton pile, r.o.m. coal outdoors.	Panama	8794	8787	8762	.....	.....
Pittsburg bed	4 tons r.o.m. coal in open bin, outdoors.	Ann Arbor, Mich.	8541	[c]8539	8526	.....	.....
			8541	[d]8553	8528	.....	.....
Sheridan, Wyo., subbituminous	R.O.M., open bin, 5 ft. deep.	Sheridan, Wyo.	7370	7174	.....	7135	[f]3.19
	R.O.M., closed bin 5 ft. deep	Sheridan, Wyo.	7370	7202	.....	7094	[f]3.75
	R.O.M., closed bin, 15 ft. deep.	Sheridan, Wyo.	7370	7303	.....	6982	[f]5.26
	Slack, closed bin, 15 ft. deep.	Sheridan, Wyo.	7355	7166	.....	6990	[f]4.96

[a] Heating value of representative mine sample of coal (ash, moisture, and sulphur free) 8,768 calories.
[b] On basis of original heating value of same test portion.
[c] After six months' storage, entire lot in bin.
[d] After six months' storage, upper 6 inches at surface of bin.
[e] Each bin contained 5 to 10 tons.
[f] After two years and three-quarters.

Table 1 gives a condensed summary compiled from the results of a large number of tests and determinations. The moisture, ash, and sulphur contents and calorific value of each sample were determined. A Mahler bomb calorimeter and a carefully calibrated Beckman thermometer were used in the calorimetric work, and nearly all the work was done by one of the authors and with the same calorimeter. To eliminate the effect of incidental impurites that were not concerned in the deterioration of the actual coal substance, the calorific values are calculated to a moisture-, ash-, and sulphur-free basis, and the ash as determined is corrected for errors due to oxidation of pyrites and dehydration of shale or clay.

The results show in the case of the New River coal a loss of less than 1 per cent of calorific value in one year by weathering in the open. In two years the greatest loss was at Key West, 1.185 per cent. There was practically no loss at all in the submerged samples in one year, fresh or salt water serving equally well to "preserve the virtues" of the coal. There was almost no slacking of lumps in the run-of-mine samples. In all tests the crushed coal deteriorated more rapidly than the run-of-mine.

The Pocahontas run-of-mine coal in 120-ton pile on the Isthmus of Panama lost during one year's outdoor weathering less than 0.4 per cent of its heating value, and showed little slacking of lumps.

Gas coal during one year's outdoor exposure suffered practically no loss of calorific value measurable by the calorimetric method used, not even in the coal forming the top 6-in. layer in the bins.

The Wyoming coal in one of the bins deteriorated in heat vaule 5.3 per cent during storage for 2¾ years, and more than 2.5 per cent in the first three months. There was bad slacking and crumbling of the lumps on the surface of the piles, but even where this surface was fully exposed to the weather the slacking did not penetrate more than 12 to 18 in. in the 2¾-year period.[1]

The Bulletins Nos. 17 and 38 of the University of Illinois Engineering Experiment Station are well worthy of study in connection with this subject.

Heating and spontaneous combustion of coal are caused by absorption of oxygen by both the organic and inorganic constitutents and are more active in coals exposing large surfaces to chemical action. In other words, lump coals generally absorb oxygen to a lesser degree than slack coals because of the relatively smaller surfaces exposed to the action of the atmosphere.

A pile of coal is, in itself, a very poor conductor of heat. This is shown by the fact that fire has often been detected within a very few feet of thermometers placed in the pile to check rise of temperature.

UNIVERSITY OF ILLINOIS STUDIES

The oxidation of coal is continuous over a wide range of time and conditions, and begins (at ordinary temperatures) with the freshly mined coal. A number of oxidation processes are involved, which are more or less distinct in character, some being relatively slow and moderate in form, while others are rapid and vigirous in their action.[2]

In general it may be said that for a given coal a point exists, as indicated by the temperature, below which oxidation is not ultimately destructive. The continuance of this point is dependent upon certain accessory conditions; if these conditions are withdrawn the oxidation ceases. On the other hand, above this critical point, which is best indicated by temperature, oxidaton is ultimately destructive and is characterized by the fact that it does not depend for its continuance upon external conditions, but is self-propelling or authigenous.

The point of authigenous oxidation, while varying for different conditions, may be indicated by the temperature of the mass ranging from 140 deg. to 160 deg. C. in an atmosphere of oxygen, or approximately between 200 deg. to 275 deg. C. in oxygen diluted with nitrogen, as in air, depending to a great extent upon the fineness of divisions. The phenomenon of fire or actual kindling does not occur until a much higher temperature is reached, usually beyond 350 deg. C.

The temperature at which authigenous oxidation begins is the sum of numerous temperature components, each one of which, either because of its own contribution to the total heat quantity or because of its function as a stimulus for chemical activities, must be looked upon as a dangerous factor, tending directly to the ultimate result of active combustion throughout the mass. An enumeration of the more important elements which contribute toward this end follows.

(*a*) *External Sources of Heat:* Oxidation, especially of the lower or moderate form, is greatly accelerated and in certain phases directly dependent upon an increase of temperature. What may be external or physical sources of heat, and thus presumably avoidable, are suggested by the following list:

(1) Contact of the mass with steam pipes, hot walls or floors under which are placed heat conduits of any sort.
(2) The heat of impact or pressure due to the method of unloading or to the depth of piling.
(3) Climatic or seasonal temperature at the time of storage.
(4) Direct absorption of heat from the sun or from reflecting surfaces.

(*b*) *Fineness of Division:* Coal in a fine state of division presents a very much larger surface and brings a much larger quantity of reacting substances in contact with oxygen than when in solid masses. Under these conditions, with a condensation or accumulation of relatively large amounts of oxygen immediately surrounding or in contact with the particles of carbonaceous matter, the circumstances are exceedingly favorable for rapid oxidation upon the arrival of the mass to a suitable temperature. But more especially does this fineness of division facilitate the initial form of oxidation described under (*c*).

(*c*) *Easily Oxidizable Compounds:* A first or initial stage of oxidation exists in bituminous coals which does not result in the formation of CO_2. Unsaturated compounds are present in coals of this type, which have a marked avidity for oxygen at ordinary temperatures, the products being humic acid or other fixed constituents of the coal texture. Coals vary widely in this respect, and it has been proposed by some to regard this content as an index of the liability to spontaneous combustion. It is, however, very largely dependent upon the freshness of the coal and upon the fineness of division (see *b*), and should be looked upon as a contributing factor, although in coals of the Illinois type, at least, with their high percentage of sulphur, this action should doubtless be considered second in importance to that of iron pyrites.

(*d*) *Iron Pyrites:* The presence of sulphur in the form of iron pyrites is a positive source of heat due to the reaction between sulphur and oxygen. This may be conveniently referred to as the second stage in the process of oxidation. Here again rapidity of oxidation is directly dependent upon fineness of division. Since coals, as a rule, have a much higher earthy or ash content in the fine dust, and since iron pyrites is a large component of this material, it follows that the presence of dust in all coals of the Illinois type is a positive source of danger. Since the majority of coals of the Illinois or mid-continental field run over 6 per cent pyrites, the heat increment from the oxidation of only one-fifth of this material is sufficient to raise the temperature of the mass approximately 70 deg., assuming that there is no loss by radiation. Under usual conditions, and especially considering the greatly accelerated rate of chemical activity accompanying a rise of temperature, this oxidation may proceed with such

[1] Technical Paper No. 16, Dept. of Interior, Bureau of Mines.
[2] Bulletin No. 46, University of Illinois, p. 50.

rapidity that the heating up of the mass will be but little affected by loss of heat due to radiation, except in relatively shallow piles.

(*e*) *Moisture:* While essential to pyrite oxidation, moisture is given separate mention because its importance is apt to be under-estimated. The oxidation of any coal will be facilitated by moisture under favorable conditions. It is to be noted in this connection that the normal water content or vein moisture of coals in this region is rarely below 10 per cent and ranges usually from 12 to 15 per cent. The presence of such water must be borne in mind in considering the likelihood of chemical activity on the part of the pyrites present. Without exception, in all the series of tests the wetting of the coal increased the activity, as shown by the ultimate temperature.

(*f*) *The Oxidation of Carbon and Hydrogen:* A third stage in the oxidation of carbonaceous material exists by reason of the tendency of certain of the hydrocarbon compounds of coal to oxidize with the formation of CO_2 and H_2O at temperatures in excess of 120 to 140 deg. Although this type of oxidation does not appreciably take place at ordinary temperatures, it must be looked upon as an exceedingly dangerous stage in the process, owing to the very much higher quantity of heat which is discharged by the oxidation of carbon and hydrogen, so that the temperature of authigenous action, although ordinarily occurring at a higher point by 100 deg. or more, may be quickly attained as a result of this form of oxidation. Any initial heat increments, therefore, which threaten to bring the chemical activities along to the point where the oxidation processes invade the carbonaceous material in this manner must be looked upon as dangerous. For example, any of the initial or contributory processes which result in raising the temperature of the mass 50 deg. above the ordinary temperature would, in all probability, have enough material of the sort involved in such action to continue the activity until another 50 deg. have been added, and would thereby attain to the condition wherein this third type of oxidation would begin.

The fourth stage of oxidation may be indicated as occurring at temperatures above 200 to 275 deg. and differs from the previous stages in that the action is authigenous and not dependent upon other sources of heat to keep up the reacting temperatures. Activity in this stage is further accelerated by the fact that above 300 deg. the decomposition of the coal begins, which is exothermic in character, thereby contributing somewhat to a further increase in temperature. The ignition temperature is reached at a point still further along, usually in excess of 300 to 400 deg. C.

PREVENTIVES

The above formulation of the various stages and types of oxidation clearly indicates the principles which must be observed in any attempt at the prevention of spontaneous combustion. The following enumeration, therefore, of preventative or precautionary measures is to be suggestive rather than complete in character.

(*a*) The avoidance of an external source of heat which may in any way contribute toward increasing the temperature of the mass is a first and prime essential.

(*b*) There must be an elimination of coal dust or finely divided material. This will reduce to a minimum the initial oxidation processes of both the carbonaceous matter and the iron pyrites. These lower forms of oxidation are to be looked upon as forces, without which it would be impossible for the more active and destructive activities to become operative.

(*c*) Dryness in storage and a continuation of the dry state, together with an absence of finely divided material, would practically eliminate the oxidation of the iron pyrites.

(*d*) Artificial treatment with specific chemicals or solutions intended to act as deterrents does not offer great encouragement, though some results seem to warrant further trial in this direction.

(*e*) By means of a preliminary heating, the low or initial stages of oxidation are effected. These sources of contributory heat being removed, the forms of destructive oxidation are without the essential of a high starting temperature and are therefore inoperative.

(*f*) The submerging of coal, it is very evident, will eliminate all of the elements which contribute toward the initial temperatures. As to its industrial practicability, like the conditions under (*e*), this can best be determined by actual experience.

(*g*) Other processes may be suggested by the formulation of the principles involved. Such, for example, would be the distribution throughout the coal of cooling pipes through which a liquid would circulate having a lower temperature than the mass. This would serve to carry away any accumulation of heat and confine the oxidation to the lower stages only. The proposition sometimes made to provide circulating passages for the transmission of air currents is, on the contrary, of questionable value, since it might by the added accessibility of oxygen result in the contribution of more heat than would be carried away by the movement of the air.

STORAGE UNDER WATER

For complete protection of coal from spontaneous heating the only sure method to-day is the storage of coal under water. This method is used by the United States Government at its coaling stations on the Panama Canal, by the Western Electric Company in Chicago, and in other places. The objections to this method are the moisture contained in the reclaimed coal and the liability of freezing in localities where low temperatures prevail.

Two methods of storing coal are in general use, one where the storage is purely a reserve and the coal is of such character as will store without material loss; the other is where spontaneous heating is to be expected. This indicates the advisability of using the storage pile for freshly mined deliveries, withdrawing from it for daily use. This last method is applicable without large additional expense only to storage piles adjacent to generating plants.

It is very difficult to arrive at a definite conclusion regarding the qualities and characteristics of coal that can be stored without danger of spontaneous heating. A fair assumption is that coal which has such characteristics as enable it to resist atmospheric influences resulting in air slaking, is better suited for storage than coal of opposite characteristics. The presence of sulphur and moisture has a bearing on the subject, but contrary to many expressed opinions, as indicated above, it seems reasonable to conclude that sulphur is not a governing factor, but simply one of many causes. Moisture in small quantities without doubt accelerates

the absorption of oxygen and increases chemical activity. In connection with the sulphur content of coal and its effects on spontaneous heating, it should be noted that the instantaneous combustion of 1 per cent sulphur in the coal would raise the temperature to about 135 deg. F. This rise in temperature is entirely insufficient to bring the coal to a point of ignition, and it must be borne in mind that the oxidation of the sulphur must necessarily extend over a considerable time during which radiation from the pile would generally dissipate all of the heat.

Many authorities have recommended that stored coal be piled not to exceed 12 to 20 feet in depth. Undoubtedly where space limitations are not to be considered, such advice is good, but it must be borne in mind that the depth of the pile affects practically only the loss of the heat in the pile itself by radiation and convection. Therefore, no arbitrary height can be set as a limit for coal storage piles, as this depends largely on the nature of the coal stored. It has been a matter of general observation that freshly mined coal heats more rapidly than coal which has been exposed to atmospheric conditions for some length of time. Therefore, it has been necessary in certain cases to rehandle freshly mined and stored coal after a short period, exposing the coal to the atmosphere and allowing it to cool down by radiation, and then restocking it, after which there has been no trouble from heating.

This has not been the experience with all observers, but in all probability the different results which have been noted were due to differences in the characteristics of the fuel both as regards constituents and size.

It must be borne in mind that one of the most important considerations in connection with coal storage is the matter of size. As has been noted already it is the surface of coal exposed to atmospheric conditions that governs the absorption of oxygen. Lump coal becomes oxidized on its surface and after absorption to a small degree is practically inert unless such oxidation results in a breaking up of the lumps, although even without this breaking up there may be more surface exposed by the creation of fissures or a crazing of the surface.

In all of the literature consulted, the Committee has found no case on record of lump coal having suffered from spontaneous ignition. This is true for coals of widely different characteristics, and is as true for high volatile gas coals as for low volatile steam coals. Where, however, coal is stored with a large percentage of slack, heating to some extent is practically universal. Rehandling has checked further heating, but if left in the pile spontaneous ignition is bound to occur.

The Committee has undertaken no research work in connection with this problem, the plan being to gather in a practical way such ideas and suggestions as may be of use of those who have the storage problem in mind. Protection of storage piles by admitted ventilation has proved more dangerous than no protection. Suggestions have been made for the introduction of gases which will not support combustion and of steam for subduing fires already in progress, but such methods have not as yet been marked by any pronounced success. It can be accepted as final that eternal vigilance in the handling of stock coal is the only way by which loss can be guarded against. Checking rise of temperature is a good method, but it must be borne in mind that because of the poor conductivity of coal fires may exist within very short distances of points of observation.

The Treatment of Metallurgical Smoke in Japan

By Tetsurow Komakine

The European wars have stimulated the industry of metallurgy in Japan, especially copper metallurgy. At the same time almost a dozen cases of smoke damage were raised by tenants and the landlords.

Now there are two main investigations of the treatment of metallurgical smoke in this country; one is being undertaken at the Hitachi Mine, the other at the Ashio Mine, which are the largest copper producers in this country. It will be of the most interest to discuss separately their methods of attacking the problem.

Recently at the Hitachi Mine an aircraft (perhaps it is better to say a sack filled with hydrogen) was utilized to examine the air currents at great heights above the mine. This will no doubt furnish much needed data to aid in solving the smoke question. At the mine hitherto careful attention has been given to the smoke ejected from the present chimney, 511 ft. high (it is called the tallest one in whole orient) which is built on a mountain about 700 ft. above sea level. In these investigations many field laboratories were erected at intervals on the circumferences of circles (ranging from one mile to some fifty miles in radius). These estimated the SO_2 gas in the air at the respective positions, and attempted to reach some conclusions concerning the relation between the distribution of gas in air and the air currents, as well as to study the harm due to the smoke itself.

It has been generally thought that when the smoke is discharged from the chimney, the further the distance from it the more diluted the gas will be with air. That is, the concentration of the gas in air is inversely proportional to the distance from the chimney. But after these investigations were finished, the facts appeared to be quite contrary to this theory. The supposition above mentioned is not always true, since they sometimes found a higher concentration of SO_2 at a greater distance from the chimney, while they also found lower percentages of it at short distances from the mine. And both the SO_2 content of the air and the place where the maximum appears are quite variable and fortuitous. In a certain season, point "A" has the densest smoke of all places, while in the next season place "B" is the densest, while in the next, place "C." Even the change of this concentration is very irregular, and beyond prediction.

For these reasons, it was impossible to estimate the damage of smoke from such skin-deep studies. Consequently not only a study of the gas conditions at the ground but another of the upper air currents was thought necessary. In these experiments it is planned to sample the upper air by means of the aircraft in order to estimate the percentage of the sulphur dioxide in it. Such a study will be of great value in the design of a chimney to minimize the smoke nuisance.

As a matter of fact, it is intended to discharge all the smoke out to sea at the Hitachi mine away from the land, by means of the prevailing air currents. For

this purpose, a great chimney 1000 ft. high (perhaps it will be called the tallest in the world) is making fast progress toward completion. Such a solution of the problem was forced by the imminent damage suits, and the difficulty of the study of smoke control and the scanty opportunity for it.

Sulphur dioxide is easily soluble in water, so that when the gases are scattered in the air by the wind or air current and meet with water vapor (that is, clouds) it forms a dilute solution of sulphurous acid which later falls down to the ground in the shape of rain. Even if they remain in suspension, the dense vapors of H_2SO_3 forms a huge mass of clouds passing to and fro and causing excessive damage to the vegetation. Owing to the famous tobacco-farms around the mine, this nuisance, no doubt, was held most seriously by the farmers. And also it is obvious that these clouds move as the wind blows. Therefore, it is impossible to manage the migration of the gases since all the air currents are not fully known in their details. Especially so in the Hitachi district where not only the rugged forest land but the misty climate makes the current extremely irregular.

From these viewpoints it is evidently necessary to look into all details, because the concentration of the mixture of the gas and vapor is changed with the temperature, time of day, season, weather, altitude and other factors. At the Ashio mine the smoke studies have been prosecuted for several years, but the conditions are quite different from those surrounding the investigations at Hitachi. Ashio's studies have been based upon Cottrell's electric precipitation process. But though it is easily possible to settle all the solid matter and fume containing Cu, Sn, Pb, As, Sb, S and C, the precipitation of SO_2, a true gas, is unfortunately beyond the scope of the process. Therefore, colorless as the smoke becomes, it contains an unchanged percentage of SO_2, and which is freely discharged in the air. This is a weak point of the process. Ashio is now endeavoring to remedy this by developing processes for catching the gas.

This will be a pretty hard matter since there are no available references to similar work in Europe and America. In Ashio's method, the main principle consists of making a harmless substance out of the SO_2 gas, while Hitachi's method only sweeps the smoke from the land and the farmers. If practicable it no doubt will be the better method than the latter.

It is not an impossible matter; since all the solid substances are precipitated by electricity, it is also easily possible to catch the SO_2 after it has been changed in a solid form.

Some years ago an opinion was published on this subject, the idea utilizing limestone. But unfortunately electricity had not then been used for smoke precipitation at the time. A special apparatus is arranged at one part of the flue which leads from the furnace by which water is sprayed into the flue. This water is readily changed into steam by the heat in the flue gases and the SO_2 which passes there immediately reacts with the steam. The mixture is now introduced into a cooling chamber which is either arranged separately from the flue or directly beyond the spray. For example, pair of rooms are partitioned off in the flue, the first of which is filled with crushed pumice and the second with limestone. The first room is cooled to constant temperature and moistened by the water-spray. When the gas passes this chamber the SO_2 and water vapor contained, soon changes into a liquid solution of H_2SO_3 on account of the lower temperature. This solution seems quite concentrated. This can be easily appreciated, although there is no record of its specific gravity, by the extremely quick decomposition of the limestone contained in the next room to the cooling chamber, where the H_2SO_3 water is introduced. There it combines with the $CaCO_3$ and becomes $CaSO_3$, whose properties are neutral and harmless, and it can be thrown away. At least three limestone chambers are required in this case. It is evident that the action of H_2SO_3 in the first chamber is exceedingly rapid, in second somewhat slower, and in third very small. After the SO_2 is expelled the smoke is next discharged by means of a fan after all the dust and fume is settled.

At the time this method was only considered in principle or theory without figuring its cost, or the utilization of the product $CaSO_3$. I believe that this method is not impossible to apply in modern practice if the by-product could be utilized. By this method we can easily effect a clearance of 85 per cent while in the milk lime method (described below) only 70 per cent. The only material required in the process developed at Ashio is the limestone, which can easily be obtained at metallurgical plants.

In a similar process to that above mentioned, SO_2 is mixed with steam and then at the certain part of the flue a limestone powder is jetted into the gas with a strong blast of air. The SO_2 becomes fixed in $CaSO_3$ which may be settled by electricity and finally we have a harmless gas to be discharged from the chimney. As before mentioned, when this process is applied in practice we must consider the treatment of the $CaSO_3$ produced, because, even though this method is suitable theoretically, it is difficult to apply, since so far we have no economical utilization of the product by which we may regain part of the cost of the treatment.

Therefore we finally come to the conclusion that we must plan for the utilization of the calcium sulphite, if this method is to be adopted. A suggestion for this is briefly stated as follows:

Sulfurous acid is the most important material for the paper mill in making paper pulp. But in Japan the demand for the acid is rather small since the paper milling industry is not active at present. We have only one such factory which is in Karafuto and which is so far from any smelter that transportation will be very difficult. We conclude that it is hopeless to supply the acid for paper milling, since the crude product contains $CaSO_3$, CaO, S, Zn, Cu, Sb, Pb and C. This mixture has no present use. If it were necessary to treat it, it might be possible to extract sulphur from it. If that were done, what would be the result? If the SO_2 from all the chimney gases in the plants treating the sulphides in this country were condensed to elementary sulphur, we would produce about 100,000 tons of it in a year. This amount is greater than the total production of sulphur in Japan in a year (that is, 80,000 tons). Or if sulphuric acid would be manufactured, the quantity would be far beyond the consumption of Japanese industry. And if the produced acid could not be sold to consumers, what could be done with it?

As before mentioned, the extracted sulphur is cheap in cost as well as impure, and naturally the price of

manufactured sulphuric acid is low. Consequently almost all the pyrite used in acid plants will be replaced by this by-product sulphur. This condition cannot be called a favorable one in mining economy. Not only would pyrite lose its value but the copper metallurgists also would at the same time have no way to get their clinker.

They would be forced to roast the pyrite themselves, which would be a big undertaking at the present time in Japan. And if it were accomplished, what is the thing discharged from the chimney? SO_2 gas! I fear all the meaning and purposes for adoption of the method is destroyed. That is, on one hand they endeavor to get rid of a gas, and on the other hand they make the gas for the sake of itself. Sulphur is burned into SO_2, and SO_2 reduced again to sulphur. Thus sulphur circulates alternately gas to solid, solid to gas, and I cannot say it is a good practice to circulate the sulphur to no purpose; it is only a waste in cost and apparatus.

Now a word about the utilization of calcium sulfite. We can use the product in agriculture as a fertilizer instead of extracting the sulphur from it. That is to say, we never again liberate the SO_2 from the fixed state.

Then at the right we catch the SO_2 and at the left can change the enemy of the farmer into his friend. A satisfactory solution of this troublous problem which has been open so many years in Japan will doubtless appear in the near future.

Narayama, Akita, Japan.

Japanese Production and Exports of Sulphuric Acid

Since the beginning of the year the price of sulphuric acid in Japan has been steadily advancing owing to increased exports to Russia and China, and also to the Allies for war purposes, according to *Commerce Reports*. As a result, some of the artificial-fertilizer companies have reduced the output of fertilizers and devoted their energies to the manufacture of sulphuric acid, while a number of companies have been established exclusively for the manufacture of the chemical. Its output has accordingly increased in a large measure, and some anxiety is entertained with regard to overproduction after the war. According to latest investigations, the present total output in this country amounts to 582,500 tons a year, excluding the output of a few factories that is not made public. Of this quantity, 421,150 tons is consumed by the manufacturers themselves for the manufacture of sulphate of ammonia, hydrochloric acid, etc., leaving the remaining 161,150 tons available for general requirements. The domestic demands now amount to about 100,000 tons a year, so that the quantity for export is about 60,000 tons. It is taken for granted that on the conclusion of the war the exports will fall off, while it is also very probable that the stoppage of war industries will cause a considerable decline in domestic requirements.

It is estimated that the output of sulphuric acid, if turned out at the present rate, will be in excess of the demand by about 100,000 tons on the resumption of normal conditions after the war has been concluded.

Radio-Activity and Some Advances in Physical Science[1]

By Howard H. Barker

The study of radioactivity has opened up an extensive field of research, which has led to a new conception of our old ideas and given us a better insight into the nature of matter. As a result of Becquerel's discovery in 1896 of the peculiar radiations emitted by all uranium compounds, some thirty new elements have been discovered, which are characterized as being radio-active.

In order to explain the phenomenon of radio-activity, Rutherford and Soddy have advanced the theory which regards the atom of the radio-active element as suffering spontaneous disintegration, and giving rise to a series of radio-active substances which differ in chemical properties from the parent element. That is, the property of radio-activity is a phenomenon which occurs from within the atom, and as far as is known is not affected by any chemical or physical agencies which one can apply from without. To illustrate this property of intra-atomic disintegration, the uranium atom loses a helium atom carrying two units of positive electricity and resulting in the product uranium X_1. This helium atom carrying the two positive charges of electricity, known as the alpha ray, is expelled with a velocity of about one-tenth that of light. Uranium X_1 undergoes a further atomic disintegration with the expulsion of a particle carrying a unit negative charge, known as the electron or beta ray, and producing a new element uranium X_2. The beta rays or negative electrons are expelled with a velocity comparable to that of light and are quite analogous to the cathode rays. The third type of radiation which usually accompanies the beta rays is known as gamma rays and is quite analogous to the X-rays. They consist of ether vibrations of exceedingly short wave lengths.

Perhaps the most striking characteristic of the radio elements is their rate of decay or transmutation. The rate of decay for each element, which has been determined by actual observation rather than atomic weight determinations, due to the fact that radio-activity allows the study of very small quantities of these substances while atomic weight determinations would require relatively large amounts. Uranium, radium, radium emanation, ionium and thorium are the only members of the radio-active family that have been obtained in large enough quantities for atomic weight determinations.

For radio elements of long life such as radium with a "half period," by which we mean the time for one-half of the original amount to disappear, of 1750 years, or uranium whose half decay period is about five thousand million years, more or less indirect methods must be used. The half decay period for these long-lived substances may be ascertained by determining the number of alpha particles emitted from a known weight of a substance in a definite time. Since a gram atom of an element contains 6×10^{23} atoms, it is an easy matter to calculate the fraction of the number of atoms present decaying per second, each alpha ray representing one atom of radio-active matter undergoing transmutation.

In this connection it is perfectly correct to say that

[1] Paper read before The Teknik Club, Denver, Colo.

we are counting the number of atoms or molecules in a given substance with just as much accuracy as we count the inhabitants of a city. No census is correct to more than one or two parts in a thousand and this represents about the degree of accuracy with which we are able to actually count the number of atoms or alpha particles. An interesting simile was given in an address by Sir J. J. Thompson to show the great advantage of detecting electrified bodies over unelectrified bodies. Professor Strutt, by means of the spectroscope, was able to detect the neon in 1/20 cm³ of air. Ramsay established that only 1/100,000 part of the air is neon, therefore the neon in 1/20 cm³ would occupy 1/2,000,000 of cm³ at S. T. P. In this small volume there are about ten million million molecules. The population of the earth is established at about fifteen hundred million, so that the smallest number of molecules of neon we can identify is about 7000 times the population of the earth. In other words, if we had no better test for the existence for a man than we have for an unelectrified body of molecules, we should come to the conclusion that the earth is uninhabited. If the alpha particle had been uncharged, we should require more than a million mollion of them instead of one before we would have been able to detect them.

For the radio-elements of comparatively short half-period, such as radium emanation with a half period of 3.85 days, the electroscope may be readily used in determining the period of decay.

Now let us consider for a few moments a little more in detail these various types of radiations and their peculiarities. The alpha rays in their passage through matter cause ionization and thus render air a conductor of electricity and so discharges electroscopes, thus giving the basis for radium and radio-active measurements. They also affect photographic plates and produce phosphorescence in certain substances, for example, Sidot's blend or phosphorescent zinc sulphide. This phosphorescent effect analyzed has been shown to consist of individual flashes of light.

Sir Wm. Crookes has devised a simple apparatus known as the spinthariscope for observing the scintillations due to radio-active matter. It consists of a trace of radium concentrated at a point and placed several mm. away from a zinc sulphide screen, which is fixed at one end of a short tube, and viewed through a lens at the other end. One then sees hundreds of scintillations, each one of which is due to the bombardment of an alpha particle against the zinc sulphide screen, thus indicating the transmutation of an atom of radium at the point. The rays are slightly deviated in a strong magnetic field at right angles to their path. The alpha rays from different radio-active substances have different velocities of expulsion and ionize the air for different distances. The rays are readily absorbed by thin sheets of paper or metal foil or a few centimeters of air due to the large mass of the particle and to its low velocity. Upon stopping the alpha particles their extra energy is converted into heat. One gram of radium has been found to produce 134 cal. of heat per hour, of which 124 cal. are due to the alpha particle. From these figures it has been calculated that the disintegration of one gram of radium and its disintegration products develops at least 400,000 times as much heat as can be obtained by burning one gram of carbon, or a simple calculation will show that one pound of radium has inherent within its atoms the heat energy equivalent to 400,000 pounds or 200 tons of coal. One ounce of radium in its complete transformation to the end products will give off enough energy to lift 5,000,000 tons through a distance of thirty feet. In other words; one ounce of radium will give off enough energy to lift one hundred of the largest battleships afloat entirely out of the water.

The beta type of radiations from radio-active substances are more penetrating than the alpha rays due to the relatively small mass, about 1/1700 the mass of the hydrogen atom, and the comparatively large velocity. Beta rays are more readily deflected by a magnetic field than the alpha rays. The ionization effect of the beta rays are about 1/100 that of the alpha rays over the same distance.

Gamma rays never appear independently of the beta rays and are probably produced by the beta rays just as the X-rays are produced by the cathode rays. They are not deflected by a magnetic field. They are very penetrating as is shown by the fact that they will pass through the human body or through one foot of iron, but their ionization effect is only about 1/10,000 that of the alpha rays.

The beta and gamma rays as well as the alpha rays are capable of producing phosphorescent effects on certain minerals, but not to the extent that the alpha rays are, while the gamma rays are even less intensive in their effect than either of the other two.

The beta and gamma rays are finding a very valuable use in the treatment of many malignant growths such as cancer, and it has been for this reason that radium has a commercial value. Lately the use of radium mixed with phosphorescent zinc sulphide for the production of permanently luminous preparations has become of commercial importance. This material is used on the dials of watches, compasses, etc., to render them visible in the dark.

The chemistry of the radio-elements and the work on the constitution of the atom which has grown out of the study of the radio-elements and their rays presents a far more interesting field than the technology of radium, particularly since the various phases of treatment of radium ore cannot be detailed minutely. One of the most powerful methods of obtaining information on the internal structure of the atom lies in the study of the scattering of the high speed particles; for example, the alpha and beta particles in their passage through matter.

Sir J. J. Thompson in assuming that the atom consists of a positive sphere of electrification, in which moved the "corpuscles" or electrons was able to account for many of the properties of matter, both material and electrical. Rutherford assumes this positive electrification concentrated at the center and is very small compared to the total space occupied by the atom. This theory was advanced to explain the scattering or deviation of alpha rays from their paths in passing through matter, the assumption being that the very sharp bends in the path of the alpha ray indicate an approach of the alpha ray to the nucleus, causing the deviation.

In this connection we can say that the head-on collision of an alpha particle with a hydrogen atom re-

sults in the nucleus of the latter being projected beyond the range of the alpha particle. By experiment Marsden found that the hydrogen nucleii produced scintillations on a zinc sulphide screen at a range of about four times as great as the particle. Some mathematical investigations by G. C. Darwin indicate that the alpha particle and the hydrogen nucleus must have approached so close that the centers were about 1.7×10^{-13} cm. apart. This result affords evidence of the extreme minuteness of the nucleus as compared with the size of the atom 1×10^{-8} cm.

Correlated with this is the interesting result of Barkla, obtained some years earlier, who showed from the scattering of Röntgen rays that the number of electrons in the atom must be about $\frac{1}{2}$A, where A is the atomic weight. As is well known, the mass of the negative electron is about 1/1700 the mass of the hydrogen atom, so that the bulk of the mass of the atom must reside in the nucleus, and this is accounted for on the basis of the electro-magnetic mass by the fact that the nucleus is so much smaller than that of the negative electron. Thus we see that the atom is a miniature solar system, the sun is represented by the positive charge nucleus, which constitutes the main mass of the atom, the planets by one or more rings of electrons revolving rapidly around the nucleus giving rise to the chemical properties and visible spectrum depending on the number and arrangement of these outer electrons. The gravitational force is replaced by the electrical attraction between the positive nucleus and the negative electrons.

It was thought, though without experimental evidence that the X-rays and the gamma rays were of the nature of ether pulses. Their extreme short wave lengths made measurements impossible until it occurred to Laue that the atoms in a crystal might serve as a grating for the defraction of these rays, when their nature was definitely proven. Mosely applied this idea with marked success to the determination of the nuclear charges of the atoms of most of the elements. It might be well to state that there can be excited by the elements definite vibrations of short wave length which we call X-rays, and a simple relation has been observed between the frequencies of these X-ray vibrations of the elements and the elements when they are set in the order of their increasing atomic weights. Mosely bombarded the elements one after the other by electrons as cathode rays and reflected the resulting Röntgen rays from a crystal and measured the wave lengths of one or other of the principal radiations. In this manner he was able to determine the so-called atomic numbers of all the known elements from aluminium 13 to gold 79. These experiments bear out well a view first propounded by Van der Brock that each element has an atomic number, an integer representing its place in the periodic table (H1, He2, Li3, etc.). The atomic weight is not an exact integer nor of such fundamental character as the atomic number.

Rutherford has extended Mosely's methods and results to crystal reflections of gamma rays from RaB and determined the wave lengths of many lines, in particular of the two strongest. He has bombarded Pb with RaB rays and found the lengths of the radiations stimulated in the lead. He found that RaB and lead gave the same spectrums, indicating that they have the same atomic or ionic number—82. Hence, he deduced all of the atomic numbers of the elements in the uranium radium series.

All of these results are in harmony with the wonderful advances in radio-chemistry, due to Soddy, Fajans, Von Hevesy and others, that the expulsion of an alpha particle lowers the atomic number and valence by two, the atomic weight by four, and a beta ray change increases the atomic number by one and likewise the valence without change of atomic weight.

In accordance with this theory the end products in the disintegration of the uranium and thorium series are two new elements identical in *chemical* properties with ordinary lead, but whose atomic weights differ from that of ordinary lead by at least one unit each. In other words, three species of lead exist having atomic weights of 206.2 for the end product of thorium; 207.2 for ordinary lead and 208.2 for the end product of the uranium series of disintegration. These different kinds of lead are non-separable by chemical methods. They have identical spectra and chemical properties, but their atomic weights differ considerably more than those of cobalt and nickel. Hence the atomic weight loses some of its significance as a fundamental constant of nature. By what concept is it replaced? The answer is the *atomic-number*. From the structure of the atoms, those elements displaying similarity of spectra, valence and chemical properties, but the constitution of whose nucleii are different, are known as Isotopes and have the same atomic numbers.

Perhaps a more striking example of the chemical identity of elements of different atomic weights is afforded by the elements lead and RaB already alluded to. The atomic weights of these two elements differ by seven units. These elements, like the other isotopes, have different nuclear masses, but have the same nuclear charges and therefore the same number and arrangement of the electrons in the outer rings.

In this brief and scattered survey I have endeavored to make the following points:

1. That the phenomena of radio-activity, in contrast to chemical changes, represents processes occurring within the atom itself; that is, radio-activity is an intra-atomic property—an exhibition of atomic disintegration.

2. The disintegration is accompanied by the liberation of an extraordinary amount of energy in comparison with known chemical changes. Radio-activity has thus revealed a store of energy whose existence had hitherto not been dreamed of.

3. The key for the control of the rate of liberation of this energy, *i.e.*, rate of transformation of the radio-elements has not as yet been found.

4. One of the resulting atoms in many of the atomic disintegrations is the alpha particle, a charged atom of helium. Thus we are face to face with the close relationship of matter and electricity.

5. The present-day view of the structure of the atom, based upon the electrical nature of matter, affords an explanation of the new knowledge and in particular (1) the scattering of rays from radio-elements in their passage through matter; (2) the identity of the spectra and chemical properties of certain elements of different atomic weights which marks the introduction of a more fundamental constant of nature than the atomic weight, namely, the atomic number.

Denver, Colo.

Hazards of Low Voltage Mill Machinery

At the recent meeting of the National Safety Council particular stress was laid by many speakers of the present national necessity of a more intensified "safety first" campaign. Numbers of papers of interest to all engineers were read; among them, the following (slightly abstracted) was presented by Dr. C. A. Lauffer of the Westinghouse Electric & Manufacturing Co., before one of the meetings of the Iron and Steel Section. It is of interest to all engineers who have to do with the installation and operation of mill motors and low voltage circuits, so common in metallurgical and chemical plants.

* * * *

With reference to hazard, there is no such thing as low voltage. All circuits are dangerous to a degree; 500 V., D. C., is low voltage, but is very dangerous, both as to electric burns and shock; 110 V., A. C., is not likely to burn, the initial arcing has low intensity, but on a heavily fused circuit, under certain conditions, 110 V. may produce burns, and sometimes causes fatal shock.

In this paper, however, the term low voltage will apply to circuits of 600 volts and under.

Electric Codes

The Electric Code of the National Board of Fire Underwriters, relating to the construction and installation of electrical apparatus to reduce the fire hazard, applies also to reduce the electric shock and burn hazard.

The National Electric Safety Code is a noteworthy contribution to the cause of Safety First in the whole electric field. This electric code is receiving nation-wide recognition; a few state commissions have already adopted it, or part of it; a number are considering its adoption.

At the point of utilization, where the circuit is handled by non-electrical people, the isolation and insulation of the current carrying parts should receive particular attention. Precautions essential for the protection of the consumer of current would be irksome if required in generating stations, and in mills and factories, where skilled and experienced men only have access to the circuits and switchboards. The continuous requirements for alterations and repairs in mills and factories make it very inconvenient to have low-voltage circuits totally inclosed. It is contended that removing the casings from the inclosed conductors retards and prolongs alteration and repair operations without eliminating the electric hazard.

There is hazard in every industry; elevators and cranes, steam piping and boiler applications, coal mining, the chemical and explosive industries, and other pursuits, relative to the number of employees and exposed persons, are more hazardous than the electrical industry and electric applications, in the light of present developments.

Electric energy has become the most potent factor in doing the world's work. Like every other form of harnessed energy, however, it must be confined within its proper channels.

Fire and water, compressed air and steam, drugs and chemicals, likewise are safe only when confined and intelligently employed.

Current, however, can, and always should be, as safe to the consumer as gas and water now are.

Electric Shock vs. Electric Burns

The two types of electrical injuries encountered in the industries are electric shock and electric burns.

In electric shock, the patient becomes a part of the circuit, the current being transmitted through his body. The internal path of the electric current through the patient's body may become established without visible burning or with a mere puncture burn.

In electric burns, the patient's body comes in too close proximity to an electric arc. Such electric burns are the result of heat energy—they are thermoelectric burns. Other burns, as arise from arcing and electric welding, of which "flashed eyes" is a type, are due to the actinic rays of the electric arc, the patient being too remote to experience thermic burns.

In the case of short circuits, where the patient's body is interposed between the two lines, or between one side and ground, the patient's body then completes the circuit. There may be an imperfect contact, in which case an arcing distance intervenes; if hand to hand, both hands may be burned; if hand to foot, then burns may be found on both extremities, those on the feet often following the nails of the shoes.

When the circuit thus becomes completed through the patient's body with an intervening arcing space, both electric shock and burns may ensue. The human body, serving in this manner as a short circuiting medium, completes the circuit; the amount of current transmitted depends on the electric resistance of the body and the nature of the contact. The greater the intervening arc, or arcs, the less current there is available to penetrate the body. Since the human body is in series with the arc, produced by poor contact, a considerable voltage (or pressure) drop may occur in the arc, or arcs—the body, accordingly, being subjected to a relatively moderate shock. It is this fact that makes efforts at resuscitation so successful in the vast majority of cases.

While electric shock and burns are usually associated, they are thus seen to be essentially different. Persons without discoverable electric burns may indeed be fatally injured, and, conversely, persons frightfully burned may suffer less from electric shock, because, as results of the electric arcing, there is a considerable voltage drop in the arc, as just related, and because the coagulation necrosis, and charring of the burned tissues, apparently, block the flow of the current through the patient's body.

Other trauma may be associated with electric shock and burns. A slight shock, producing fright, or muscular recoil, may cause a patient to fall from an elevation, or he may sidestep into revolving machinery, and the injuries from the latter causes may be more grave than those arising from the electric circuit.

The skin resistance of the human body is relatively high, measuring approximately 4,000 ohms. The dry calloused palms of a workingman afford a much higher electrical resistance. No accurate figures can be given, as different individuals vary in their response to electric currents, and the readings for the same individual will show variations.*

*The various external and individual circumstances that influence the extent of electrical injury, in the grouping of Dr. S. Jellinek, are: "1. External: (*a*) voltage, (*b*) amperes, (*c*) number of cycles, (*d*) points of contact, (*e*) time limit of contact, (*f*) the kind of current (A. C. or D. C.). 2. Individual: (*a*) resistance of skin and body, (*b*) the path of the current through the body, or over the surface of the skin, (*c*) the condition of the mind and body."

The accurately measured electrical resistance of hand-to-hand contact, obtained by the bridge method, expressed in equivalent ohms, dry surfaces, 6 in. tin-foil contact, gives a minimum of 40,000 ohms, maximum of 140,000.†

The definite amount of electric current that may pass through the human body without danger to life has not been experimentally determined. The accidental electric contact injuries do not permit of the measurement of the amperage.

It is conceded, however, that one-tenth ampere of current passing through the body may become dangerous, one-fourth ampere may prove fatal, though seven to ten amperes are registered on the ammeter in criminal electrocutions.

It is thus apparent that the relatively high skin resistance of the human body is the element of safety in handling low-voltage lines. A moist skin, however, reduces the skin resistance.

Certain high-frequency currents are relatively safe because the current is confined to the surface of the skin. Low-frequency commercial currents, however, are prone to take an internal path.

When the skin resistance is broken, the current takes an internal path; a dangerous volume of current may then pass through the body, even at relatively low pressure. A momentary contact may result in no damage, yet the same contact, if prolonged, may result in serious injury.

High Amperage on Low Voltage Circuits

The increased hazard of high amperage circuits of low voltage arises from the high-generated capacity of the circuit. Contact with the high-voltage side of an induction coil involves no serious danger, due to the fact that the capacity of the coil is insufficient to maintain its high voltage when delivering current through the body; the induction coil may develop 5000 V., but does not sustain it. Contact with a low-voltage conductor, on a generating system developing several thousand kilowatts, however, releases an amount of energy that is relatively unlimited. The resistance of a high-amperage circuit must necessarily be low, and does not to the same extent tend to retard the flow of energy. When more energy is released the potential hazard is augmented.

The danger in a low-voltage circuit of high amperage capacity is evoked by interrupting the circuit, and is manifested by fire and flame. Such arcing may cause flash burns. Interrupting a circuit of great capacity feeds more energy into the arc, and may vaporize metal in its initial arcing; this vaporized metal, by reducing the resistance of the arcing path, may establish a dangerous arc. Low voltage does not sustain an arc, however, as does high voltage.

The hazard from "grounds," on low-voltage circuits of high amperage, accidentally grounded, however, is but slightly greater, that being a question of voltage rather than of amperage.

Some Injuries Inevitable

The Safety First campaign has achieved better methods of handling electric circuits, and has resulted in perfected mechanical devices for reducing the electric hazard. Human nature, however, "is prone to err, as the sparks to fly upward." Miscellaneous inadvertencies will arise, as operatives will forget which line is alive; or they may become so familiar with live circuits that familiarity makes them careless; switches will be opened when lines are loaded, testers make wrong connections; and through lack of attention, in various ways, some electric injuries seem inevitable. The human equation alone resists analysis, in the more complete elimination of industrial accidents, and even this, to some extent, can be regulated.

Safe Men

Systematic physical examination of prospective employees results in: (*a*) The *selection* of keen, qualified men, mentally alert and physically fit, for those posts in industry requiring such qualifications; (*b*) the *elimination* from industry of those unfit for any work in that industry; (*c*) the *adaptation* of the physically defective to posts in industry where their existing defects do not disqualify them from employment; (*d*) the *restoration* of others to industry by correcting existing defects—such as lenses to correct defective vision; dental work; surgical operations, for hernia, varicocele, hemorrhoids, etc.

The industrial physician will recommend that men with tubercular lesions and organic heart disease be not placed where they handle live circuits, but be located in some less hazardous employment where their existing defects militate less against them. The medical inspection of employees is thus a safety factor, approved of by employee and the management alike as a justifiable means of reducing the accident hazard. Only qualified men should handle electric circuits or work in proximity thereto.

Prudence

"Handle every line as if it carried 10,000 V.," is the attitude displayed by qualified electrical experts. Regard the line as "hot," unless it is positively known to be otherwise. You cannot tell when the line may become charged. Energizing a circuit on which men are making repairs and adjusting apparatus is a prolific source of hazard; hence, the need of locking switches, grounding lines, and appointing leaders in operations on live circuits and those potentially alive. Such Safety First instruction to men working on low voltages will measurably minimize the hazards associated with low-voltage systems.

Ignorance accounts for few electric injuries, carelessness for few; thoughtlessness is probably responsible for a larger portion of them.

Jumping

The jumping distance of 500 volts is one-fiftieth of an inch, which justifies the conclusion that the jumping distance of low-voltage is negligible as an electric hazard.

Contrasting with high voltage, 20,000 V. will jump

†Quoted in "Electrical Injuries," by C. A. Lauffer, M.D., John Wiley & Sons, publishers. From "Experiments of H. E. Heath," Consulting Engineer, Baker Electric Company, New York City.

	Minimum, Ohms	Maximum, Ohms
Forehead to neck (back)	3,400	4,000
Neck (back to chest)	5,300	7,500
Neck to right hand	14,000	60,000
Neck to left hand	26,800	55,000
Neck to both hands	10,850	35,000
Neck to hip	18,500	80,000
Neck to knee	120,000	170,000
Hand to hand	40,000	140,000
Hip to knee	47,000	165,000

an inch between needle points, 60,000 V. will jump 5 in. between needle points—there is a relative safety in low voltage, as regards jumping from conductors. High-voltage lines are placed high out of reach, danger signs are employed for high voltage, and in consequence of this known jumping distance, no dependence is placed on insulation; all lines are made "dead" when repair operations* are in progress. Such precautions rob high voltage of its dangers.

Reliance on Insulation

In consequence of the low-voltage jump being one-fiftieth of an inch or less, excessive reliance may be placed on the insulation of conductors. Excessive confidence in insulation, trusting in insulation for immunity against electric shock and burns, increases the low-voltage hazard. Live low-voltage conductors are handled indiscriminately in homes and factories, with the result that defects in insulation constitute a perpetual hazard to the electric consumer.

Insulation gets old and decays. Old rubber becomes brittle and breaks, exposing the conductors. Conductors exposed to wear and friction lose their insulation, and, at the thin points in the insulation, the persons handling the conductors, especially if grounded when the contact is made, may experience a shock or burn.

Attention to the renewing of service wires and leads is essential to safety from leaks through defective insulation. In good shop practice, lines and leads are inspected and measured periodically, and renewals made where defects exist, or carrying capacity so requires, thus insuring against possibilities of grounding and defects in insulation.

Dust and Dirt

While the jumping distance of low-voltage constitutes no hazard, ordinarily, a damp or dusty path may contribute to the rupture of the air resistance, permitting arcing to occur at a greater distance. Particularly when the dirt consists of iron filings or other metallic waste, and there is simultaneously defective insulation, can this increased arcing occur. After the arcing is once established it can draw off an increasing amount of current; hence, combinations of conditions can arise in which the low-voltage hazard is increased.

Flashing Commutators

Cleanliness is necessary as a safety factor in handling motors, as well as other electric apparatus and equipment. Dirt and dust accumulating on the commutator may cause it to arc over; in shop phraseology, "the commutator flashes over." The flash is from brushes to bars, or across the whole surface of the commutator.

Such arcing causes flash burns of the skin, if anybody chances to be near at the time; the actinic rays of such an electric arc, like in welding, may even cause "flashed eyes" among persons beyond the range of the heat of the arc.

Other reasons may account for commutators flashing over, such as excessive speed or load, the type of motor, and short circuits on the line, yet dirt is the commonest cause of this form of electric hazard.

If the motors are attended by practical men, and the brushes and commutators kept clean, such arcing is avoided. Conducting particles worn off the bars and brushes may short circuit the bars, unless they are kept clean.

Breaking Circuits

Starting switches for industrial motors, both for group drive, and for individual drive, require complete protection. A study of this type of hazard has developed many styles of covered switches and control apparatus which prevent the operator coming in contact with live parts. Knife switches with handle outside, so constructed that everything inside the box is dead as soon as the box is opened, is one solution of the problem of safe circuit breaking on low-voltage systems. The key is in the possession of the authorized person, who has ready facilities for access; the unauthorized person is thus kept away. Replacing fuses, or other repairs within the switchbox, present no electric hazard, as opening the box automatically breaks the circuit.

A slowly opened switch, on a low-voltage line of high amperage flow, will draw a heavy arc. Quick operating breakers of proper design are employed, therefore, to avoid flash injuries. Arcs are also broken under oil in certain types of switches.

The flash hazard, incident to opening switches on heavily loaded circuits, is also successfully solved by employing remote control; switches for high voltage are operated electromagnetically, from any desired distance, by utilizing an auxiliary switch operated on 110 V. and above.

Low voltage circuit breaking is dangerous, but it carries no insurmountable electric hazard, when the best modern equipment is used and qualified men, properly schooled in safety methods, are employed.

Short Circuits

Short circuits arise (*a*) when circuits of different voltages and different polarity are thrown together, (*b*) through the breakdown of insulation on lines, motors, generators, etc., (*c*) when a metallic conductor of relatively low resistance is placed across terminals, or conducting elements, differing in potential.

The personal element enters largely into this phase of electric hazard; bare lines are allowed to touch; a screw driver slips and goes across a bus bar; pliers, or other tools, inadvertently cross the two lines.

The intensity of "short circuits" will depend on the size of the units that are connected to that line, and the setting of the protective devices, as fuses, relays, circuit breakers. "Shorts" have a tendency to blow fuses.

A backed-up induced current may also increase the intensity of a short circuit. Thus, a large generator will be feeding a motor, or series of motors; its lines will become crossed—a cross inside of the load may feed the power of the generator into the "short circuit," and also back up the load (induced current) from the motor.

Grounds

Electric generator and motor frames are grounded, but both the outgoing and the incoming lines are insulated from ground, unless, as stated, the circuit is employed for railway purposes.

Should any portion of such circuit become grounded, however, then contact with the opposite line, and at the same time with ground, would involve precisely the

*Repair operations on live circuits up to 40,000 volts are conducted, elaborate insulation being provided for the protection of the repairmen. It is desperate practice, however, too hazardous to commend.

same electric hazard as touching ground and the trolley wire on trolley systems employing ground.

In low-voltage systems, nevertheless, either side of the line may be repaired, if the line being repaired is purposely grounded, providing contact with both sides at the same time is avoided, and providing, moreover, that there are absolutely no abnormal line conditions.

In handling any circuit, therefore, the only safe procedure is to assume that it is grounded; but as a precaution obtain the volt meter readings from line to ground to make sure that this assumption is correct. If one side of the circuit is already grounded, intentionally or unintentionally, grounding the other side produces a short circuit. If the body makes a better ground than the ground already existing there is hazard involved. If one side of the circuit is properly grounded, it is safe to work on that side—bearing in mind that the other side is "hot." Place additional ground on the line. In grounding a line, employ a big cable, not a thin wire; it is good practice for the workman to protect himself with a thick cable, or a chain, in grounding his line, as the protection might be lost through a thin wire burning off.

Standing on dry wood, or some other insulating material, is a precautionary measure, in dealing with live low-voltage circuits; the repairs in every case must be completed on one side of the line at a time, as handling both sides of the line simultaneously causes short circuits.

Insulating the body is not a safe practice in handling live high-voltage circuits, as the insulated body has a potential of its own, and this difference of potential is an electric hazard. The man working on a low-voltage line, or up to 2200 volts, is absolutely safe if the line is grounded and he is on ground. Place the man on insulated material, however, and there then exists a difference of potential between the man and the line grounded.

Transformer Breakdowns

This hazard from transformers is reduced by careful tests, conducted by manufacturers, before transformers are marketed; during a lightning storm, however, a transformer's insulation may be burned out, permitting the high-tension primary to impose its voltage on the low-tension secondary.

The precaution mentioned earlier in the paper will bear repetition. It is best to work on dead lines, but if compelled to work on live ones one should assume that every live line may carry high voltage.

A line assumed to be low voltage may actually be higher voltage, through the accidental crossing of lines —as when falling trees or electric storms cause high-voltage lines to come in contact with those of low voltage. A telephone wire and trolley line, crossing is a familiar instance of such possibilities.

Repairing Live Wires and Switchboards

(1) Avoid personal contact with both sides of the circuit at the same time. By handling just one lead at a time, what is necessary on that side may be finished before the other side is touched.

(2) Avoid "shorts"—do not allow wires or tools to make contact with both sides of a circuit at once.

(3) Operators on low voltage may be insulated from ground by standing on dry wood or other non-conductors to insure safety; or, should that side of the circuit be intentionally grounded, repairmen should be also grounded.

(4) The leader should be made responsible for the control of switches and grounding.

(5) Only qualified men should make alterations and repairs at switchboards or handle switches.

Breaking the Contact

Accidental electric contacts should be immediately broken. As the flexor muscles are more powerful than the extensor muscles, the individual who grasps an electric conductor of low voltage may not be able to release his grip.

It reduces the electric hazard, therefore, to have men work in pairs, or in gangs, so that no workman, encountering electric current, be isolated from his comrades.

Safety First instructions, varying with the sphere of service, must include methods of instantly breaking the electric contact (*a*) by opening switches, (*b*) cutting the line, (*c*) grasping patient by his dry clothing and pulling him bodily away, (*d*) removing the conductor from him by means of dry wood, dry clothing, or rubber. As the hazard from electric shock and burns is proportionate to the duration of the contact, methods must be devised in anticipation of such emergencies to expeditiously meet them.

Caution is essential for the rescuing party—cutting a conductor, for instance, might prove hazardous. All methods devised for breaking the contact, therefore, must be relative to conditions encountered, and must embody absolute safety for the rescuer.

Treatmeent of Electric Burns

The limited time allotted me and the scope of my subject permits no prolonged consideration of electric injuries, aside from electric shock.

Electric contact burns. These burns, though deep, are frequently painless, owing to the destruction of the sensory nerves and the anesthetic characterists of electric current. The slough is slow in separating in deep and extensive contact burns; the lines of demarcation that arise will indicate the extent of tissue loss that will ensue.

"Flashed Eyes"

The congestion, lachrymation, and photophobia of "flashed eyes" is best treated by cold compresses for an hour in the works dispensary before sending the patient home with instructions to stay in a darkened room, using ice cold compresses, but not ice, alternate hours, and wear smoke-lensed spectacles until the sensitiveness to light subsides.

If the flash has been near ,the thermit element may enter; the cornea may be coagulated, temporarily impairing the vision, until the separation of the opaque layer of the cornea. In milder cases, with superficial coagulation of the cornea, the irrigation of the conjunctival sac with sterile boric solution and the brushing of the dust and tissue debris from the conjunctival sac with cotton mops will remove the opaque layer of the cornea at once. While cold compresses and exclusion of light suffice for the mild cases of flashed eyes the more severe cases require atropine to allay ciliary irritation, and those still more severe, involving burns of the cornea, demand expert attention, preferably in a

hospital. Cases involving cornea burns, especially, must be kept clean and covered to insure satisfactory recoveries.

After the rather extensive observation and treatment of this species of eye injuries, I can recall no case where bona fide permanent impairment of vision, either as to corneal scars or optic neuritis, arose from "flashed eyes."

"FLASHED SKIN"

Thermoelectric burns arise, if the patient is near, actinic ray burns may develop if the exposure is more remote. They are, prevailing, burns of the first and second degree. Our treatment is not to open blisters at once, but wash cautiously, carefully removing grease and grime with cotton mops, employing gasoline and ethereal soap.*

The careless washing of such burns by unskilled persons may serve to introduce infection; yet in our opinion the flash does not sterilize the wound; the contiguous parts must first be washed, then finally the wound, using many changes of cotton mops, not using mops on the burn that have touched other surfaces.

Employing unguentine on these burns, as soon as they are washed, controls the pain. Dressings do not adhere when ointments are employed, hence the cautious use of certain ointments facilitates redressings as well as promotes recoveries.

"Flash" burns heal up promptly without leaving scars. The extensive loss of the outer skin is alarming, but not dangerous; the great blebs, the water contained acting as cushions, promote recovery, and should not be opened before they become uncomfortable to the patient.

Sulphuric Acid in 1916

Geological Survey Report Issued

The production of sulphuric acid in 1916, expressed in terms of acid of 50 deg. B., was 5,642,112 short tons, valued at $62,707,369, or over 1,000,000 tons more than the Survey's estimate given in our Feb. 1 issue, page 174. To this must be added 443,332 short tons of acid of strengths higher than 66 deg. B., not convertible into acid of 50 deg. B., valued at $10,806,757. The total value of all the sulphuric acid was therefore $73,514,126. This total includes by-product acid—that

LONG TONS OF ORE USED IN THE MANUFACTURE OF SULPHURIC ACID IN 1916

	Sulphur	Pyrite and Pyrrhotite	Gold and Silver Bearing Pyrite	Copper Bearing Sulphides	Zinc Bearing Sulphide
Domestic	261,574	324,602	1,673	568,116	531,625
Foreign	10,903	1,154,550	0	196,404	92,002
	272,477	1,479,152	1,673	764,520	623,627

is, acid produced at copper and zinc smelters. The production of acid from this source in 1916, expressed in terms of 60 deg. acid, was 1,069,589 short tons, valued at $12,158,266, to which must be added 92,802 short tons of acid of strengths higher than 66 deg. B., not convertible into acid of 60 deg. B., valued at $1,941,661. About 700 tons of acid, valued at about $21,000, was imported; practically all of this was received from Canada. No sulphuric acid was exported by this country.

In the column headed "Pyrite and pyrrhotite" are tabulated all the sulphide ores used which are not treated further for their copper, lead, zinc, gold or silver content. Much of this material doubtless contains small amounts of these other metals, but inasmuch as they are not recovered their presence in the ore is of no economic importance.

*A good formula for etheral soap, that dissolves and removes the dirt and grime and at the same time renders the area antiseptic, consists of:

Sulphuric ether	(oz)	4
Turpentine	(oz.)	1
Alcohol	(pts.)	3
Surgical soft soap	(lbs.)	4
Water, enough to make	(gal.)	1

Synopsis of Recent Metallurgical and Chemical Literature

Coking

Low Temperature Coking of Inferior Coals.—In the Journal of the Society of Chemical Industry for Aug. 31, 1917, T. F. WINMILL, research chemist of the Staveley Coal & Iron Company, Ltd., England, presents the results of experiments on the low temperature distillation of certain low-grade coals heretofore considered as waste.

Accompanying the main coal seams in some parts of England are often found seams of inferior coal substances, which with different composition and in different districts receive different names, such as "Jacks," "Branch Coal," "Bastard Cannel." As the last name implies, these coals have often some resemblance to a cannel coal, but this resemblance is not very close. They are all distinguished by their high ash content, and the very voluminous nature of the ash, making them useless for ordinary fuel purposes. Jacks and black shale may leave 80 per cent of ash when burnt, while a very good sample of bastard cannel may leave only 10 per cent. Where they occur, considerable quantities of these coals have to be raised with the main coal, and form an expensive waste product, not only from the cost of raising, but because waste tips must be provided on the surface, forming unsightly heaps which often fire either spontaneously or from other causes.

In some districts the bastard cannel is fairly uniform in composition over a wide area and contains generally between 20 to 30 per cent of ash. The associated carbonaceous matter is intermediate in composition between a "soft" coal and a cannel, as is shown by the following limiting analyses, calculated on a dry, ash-free basis:

Carbon	78.0 to 81.0 per cent
Hydrogen	5.7 to 6.0 per cent
Nitrogen	1.2 to 1.5 per cent
Sulphur	1.5 to 5.0 per cent
Oxygen	10.0 to 10.5 per cent

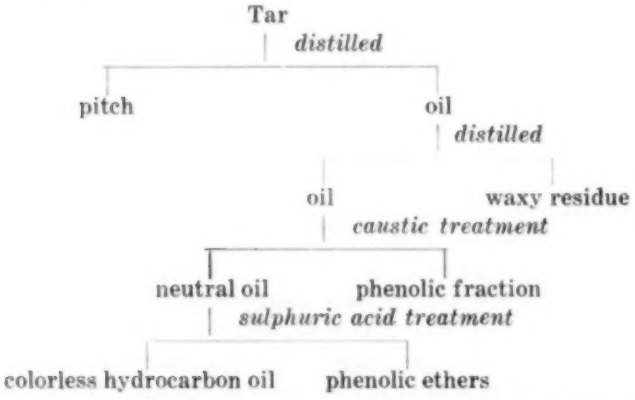
From these figures it is clear that the substance contains a large amount of potential energy which is at present wasted. The carbonaceous portion is comparable in composition to that of a good coal, so that in effect every 100 tons of branch or bastard cannel coal contains as much heat value as 70 to 80 tons of high-grade coal.

Experiments have been made therefore to see whether any portion of this potential energy can be made available in the form of oil fuel or other valuable products. In designing the apparatus, it had to be borne in mind

that the coke residuum would in any case be valueless as its ash content would be above 50 per cent. Rapid coking with the biggest possible yield of by-products was therefore the main requirement. The retort was made of cast iron, 2 in. thick, built into a firebrick chamber, and heated by five evenly placed Bunsen burners. It held a charge of 800 lb. of coal and was fitted with a very efficient stirrer working through a vacuum-tight stuffing box. The stirrer quickly ground up the charge and brought fresh portions of it continually against the hot walls of the retort, thus securing a rapid heating throughout the mass, instead of depending on the slow conduction of heat usual in any other coking oven. The distillation was carried out under a vacuum of from 26 to 28 in. of mercury, and had gone as far as it would at 500 deg. C. in three and one-half hours, after which the contents of the retort could be discharged by opening the bottom door and reversing the direction of revolution of the stirrer.

The distillation produced (1) tar and aqueous liquor condensed *in vacuo;* (2) gas which passed through the vacuum pump and was in part burnt under the retort.

The "working up" of the vacuum tar followed therefore the following plan:



The quantitative results per ton of coal distilled were:

Pitch	100 lb.
Semi-solid wax	50 lb.
Soda-soluble oil	4 gal.
Phenolic ethers, extracted by sulphuric acid	1.5 gal.
Hydrocarbon oil	6.5 gal.

The bulk of the ammonia formed was contained in the condensed aqueous liquor, and was equivalent to about 25 lb. of ammonium sulphate per ton of coal. A further quantity of 10 to 15 lb. can be extracted from the gas leaving the condensers, giving a total yield of about 35 to 40 lb. of ammonium sulphate per ton of coal.

The gas coming from the condensers is very similar in composition to ordinary coal gas, and contains very little extractable light oil. Some oil is carried mechanically with the gas, but no appreciable quantity of oil boiling below 150 deg. C. could be obtained, either by condensation or by washing. About 6000 cu. ft. of gas was produced per ton of coal distilled.

The experiments showed definitely that low-temperature distillation of a high-ash waste coal is not a commercially economical process. The initial low cost of the waste coal would at first sight seem to make it possible to work on comparatively small yields of by-products. It must not be forgotten, however, that in ordinary coking practice the price obtained for the coke made, as a rule, more than pays for the slack from which it is made, and hence in the absence of coke from the waste fuels the apparent advantage of worthless coals more than disappears, and the whole costs of the process have to be defrayed by the increased value of the by-products. In previously published accounts the quantity and nature of these products claimed have been sufficient to pay for the process, but in the light of the experiments now described it would appear that these have been estimated too optimistically. The salable products amount to 6 gal. of oil, 35 to 40 lb. of ammonium sulphate, and perhaps 2000 to 3000 cu. ft. of gas after allowing for that necessary for the distillation.

The value of the oil is difficult to estimate, as it is of a new type. It would seem to have little value except as a fuel oil, and for that purpose need not perhaps be so highly purified. Unless fairly complete purification is made, however, the oil will resinify and become of much less utility. The cost of complete purification is considerable. The phenolic substances which it is desired to remove are not very readily soluble in soda, being much weaker acids than carbolic acid, and hence the partition coefficient between the oil layer and the soda layer is so large that a considerable number of washings with comparatively large volumes of soda solution are necessary. In practice it is found that a total volume of 10 per cent soda solution equal to the volume of the oil washed, is necessary for the complete removal of the phenolic bodies. The cost of these washings, added to that of the distillations, would make it impossible to produce the refined oil at a profit in normal times. As a fuel, however, the crude unwashed oil might find a market, but in this state it could only compete with coal tar creosotes, for which the uses are limited and the price low.

It was thought that possibly by "cracking" the oil, benzenoid compounds might be obtained in sufficient quantity to make the distillation profitable, but small-scale experiments in which the oil vapors were passed over coke at 800 deg. C. gave no encouragement for larger experiments.

It must be concluded, therefore, that low-temperature distillation cannot be made to pay on the value of the by-products alone, and hence is useless as a means of utilizing waste fuels of high ash content. The process as applied to valuable coals is in somewhat a different position, for in this case a residue of "smokeless" fuel is obtained. At present it cannot be claimed that there is any very large market for such fuel in competition with coal itself, but what market may be created in the future it is impossible to estimate. Legislation in favor of smoke abatement would, of course, give a great impetus to the use of semi-carbonized fuels, since most boilers and all domestic fireplaces are not designed to burn ordinary coke, whereas the semi-carbonized fuels obtained by the low-temperature distillation of coal can often be burnt more or less successfully in existing apparatus, but they would then find a severe competitor in gas firing. Unless such measures are taken, however, the ease with which a coal fire can be maintained, and the smaller proportion of ash in a good coal (for by carbonizing the proportion of ash in the residuum is made nearly double that in the coal from which it is produced), will severely handicap the extended use of smokeless fuel.

Powdered Fuels

Use of Low-Grade Mineral Fuels.—In the General Electric *Review* for August, 1917, F. PARKMAN COFFIN, of the research laboratory of the General Electric Company, presents some interesting and important data on pulverized coal and the use of low grade fuels. Some extracts from the article are as follows:

"The efficient utilization of our fuel supplies is a subject of constantly increasing importance. Interest in this subject in America has usually been confined to the advocates of the conservation of our natural resources. The fuel supply is still abundant and it has usually been cheaper to burn high-grade coal, or fuel oil, than to bother with peat, lignite, or some of the poorer grades of coal containing a high percentage of ash. In some mining districts a portion of the coal is regarded as refuse for filling, or thrown on the culm piles.

"The reserves of bituminous coal and lignite in the United States are immense, but the supply of some of the higher grades, such as coking coal and anthracite, may be exhausted during this century.

"The unrestricted use of our better grade fuels and the ruthless waste and neglect of fuels that should be of real commercial value are phases of our national extravagance that are little short of appalling. The Bureau of Mines has repeatedly called attention to the rate at which the supplies of high-grade fuel are being depleted, and the need of investigations to ascertain how waste in their mining and utilization can be lessened or prevented.

"In spite of the immense resources, we are now face to face with a serious coal shortage, owing to limitations of transportation and of labor at the mines. At the same time there is an unprecedented demand for coal to operate the industries of the country and for war purposes."

"Parts of the country distant from supplies of high-grade fuel should endeavor to utilize their local resources to a greater extent than heretofore, in order to eliminate the expenses and uncertainties of transportation. Also the development of low-grade fuel deposits should be stimulated and established on a permanent basis."

"The production of high-grade coal and petroleum is more or less localized, but nearly every section of our continent has local fuel resources within moderate distances of points of consumption. Low-grade fuels are those which have a low calorific value due to the presence of impurities such as ash and moisture. Fine screenings and dust produced in preparing certain high-grade fuels for the market may also be included since it is often difficult to burn them on the grate, when using forced draught, even when mixed with lump coal.

"There is little doubt that the most perfect combustion of highly gaseous coals, like lignites, could be brought about by burning the pulverized material in a properly constructed combustion chamber in a draft of air. Such a method, to a limited degree, has been employed with bituminous waste for years in connection with several industries in which large ovens are used, but the machinery and appliances required have hitherto been too large and costly to permit their general adoption in small heating or boiler plants. There seems no good reason why some satisfactory method of using lignite in this manner in small plants can not eventually be evolved. Pulverization of highly gaseous lignites produces fuel with properties closely similar to those of crude petroleum or crude gas; in fact, pulverized highly gaseous coal like dry lignite, when fed into a furnace with an air blast, gives very largely a gaseous fuel.

"With the temperature of the furnace or the combustion chamber once at the proper point, by means of valves the relative supply of coal and air can be regulated so quickly and so perfectly that nearly complete combustion of the heat producing constituents can be obtained. Besides, with the proper equipment, the feed and the fire should be closely uniform, almost automatic, and requiring comparatively little work from the fireman. Why dry pulverized lignite can be used in small boiler settings to advantage, there is no reason why it should not produce a relatively high heating efficiency, for, in a proper combustion chamber, besides the combustion of fixed carbon, this method would utilize nearly all of the volatile gases, which have high calorific power, a proportion of which is lost by the ordinary methods of combustion to which lignite is subjected.

"Coal can be pulverized more cheaply than it can be gasified and the first cost of a plant for drying and pulverizing is less than for a producer-gas plant. When thoroughly mixed with a blast of air in correct proportion it is practically a gaseous fuel. Powdered coal firing has most of the advantages of gas or oil firing for steam boilers, when properly applied, and in industrial heating its field of application is constantly growing.

"Low-grade fuel may be burned on grates in furnaces of special construction for each class of fuel, and mechanical stokers are available for burning high-ash coal and lignite. It is probable, however, that low-grade solid mineral fuels of all kinds can be burned to better advantage in pulverized form.

"Lump coal, when burned on the grate in a hand-fired furnace, usually requires about 100 per cent excess air. With modern mechanical stokers the usual practice is to use about 50 per cent excess air. With most kinds of pulverized fuel 25 or 30 per cent excess air is sufficient, and with proper attention the amount may be reduced almost to zero. However, the resulting temperature of the fire is a limiting factor. Other factors having a bearing on this being the construction of the furnace, the proportion of heat radiated directly on the tubes, and the fusibility of the ash. A properly constructed furnace and burners should be able to burn any form of pulverized fuel which has sufficient volatile content.

"For the firing of steam locomotives, pulverized fuel offers a method of mechanical stoking that is beyond competition in all parts of the country where oil is not already in use. It also furnishes a means of utilizing neglected fuel."

Cotton Seed Industry

Cotton Seed Products.—In the Journal of the Society of Chemical Industry, July 16, 1917, KAPILRAM H. VAKIL gives a comprehensive article on cotton seed crushing and products, with especial reference to Egyptian and Indian seeds which constitute the bulk of the seeds crushed in the British Empire. Large quantities

of seeds are shipped to England from India but the quantity is very small compared with India's total production. Indian seed is valued in England on the basis of 18 per cent of oil.

Seeds from the Central Provinces are quoted a little higher in the bazaars and are highly valued by the seed-crushers. The hulls with the lint and moisture form about 43 to 55 per cent of the seeds and on an average 48 per cent. The lint from Indian seeds, removable by American de-linting processes, forms about 1.5 per cent of the seed. This includes lint obtained by reginning the cotton balls which are found in the seeds sold in the bazaar.

On a manufacturing scale the following products are obtainable: Lint, 1 per cent; decorticated cake, 40 per cent; hulls, 44 per cent; oil (crude), 13 per cent; wastage, 2 per cent. In the report of one of the oil mills now operating successfully in India the following figures of its working on a large scale were given: Refined oil, 12 per cent; decorticated cake, 42 per cent; hulls, 38 per cent; lint, 1 per cent; soap stock (foots), 2.5 per cent; wastage, 4.5 per cent.

American "Uplands" seeds resemble the Indian seed in many respects. The Indian seed, however, has more lint or short fiber remaining on it after ginning. This condition of the seed requires very careful handling in the extraction process as the fuzzy mass which forms the covering of the seeds absorbs oil very readily from the meal during the preliminary processes of hulling or crushing, this oil being lost to the miller. The Indian seeds are much smaller than the Egyptian and American.

The chief points of difference in the crude oils obtained from these different seeds are: (1) There is a higher percentage of free fatty acid, coloring and albuminous matters in the Indian oil than in the Egyptian or American oils, which gives rise to a greater loss in refining, sometimes exceeding from 16 to 20 per cent. (2) The oil from Indian seeds is poorer than American and Egyptian oils in the solid "stearin" obtainable from it, and not quite so well suited for margarine making. Egyptian and Indian oils are inferior in color to American oils. (3) The oil from Indian seeds retains a peculiar fishy odor which it is very difficult to get rid of even with drastic treatment. (4) The greatest drawback to the oil from Indian seeds as an edible oil is that the refined oil shows a bluish-green fluorescence. This fluorescence is not removed by the ordinary process of refining. If the traces of fishy odor and the fluorescence could be removed easily and at small cost the oil would find a ready market in India as an edible oil. At present, though sold in large quantities as edible oil, it does not command as high a price and is not valued so much as the best grades of cold pressed Til oil. (5) The refined oil from the Indian seeds has a higher iodine value—112 to 116—than the oil from Egyptian seeds, which varies from 106 to 108, or the American, which varies from 105 to 110. This higher iodine value may be due to the fluorescent substance in the oil.

The author then takes up a discussion of storage and transportation of the seeds in ships. The different processes of crushing are then discussed, with considerable detailed information on the various products. A discussion follows the paper.

Explosives

British Inspectors Report.—In the Journal of the Society of Chemical Industry for July 16, 1917, is given the following account of H. M. Inspectors of Explosives for 1916.

The inspectors report that there has again been a large increase in the number of licensed factories, 23 having been added during the year, making a total of 48 factories added since the outbreak of war. The general condition of the factories, having regard to the exceptional circumstances now obtaining, is highly satisfactory. There has been considerable difficulty, however, in impressing on the picric acid manufacturers the necessity for strict observance of the requirements in regard to cleanliness and freedom from grit in danger buildings. These factories, as a rule, are offshoots of chemical factories which are of necessity difficult to keep clean, and this, no doubt, has a tendency to cause slackness on the part of employees when they are transferred to the picric acid works. Many cases of excessive quantities of picric acid being present in packing sheds have also come to notice.

In March a committee was appointed to test the value of dry powder fire extinguishers as compared with water and other first-aid fire appliances for extinguishing or effectively controlling fires such as are likely to be caused by bombs. The general conclusion arrived at by the committee was that a plentiful supply of water is by far the best extinguishing agent, and that dry powder extinguishers are practically useless for extinguishing or effectively controlling fires likely to be caused by bombs.

Reference is also made to the appointment of the Committee on Dissolved Acetylene.

The Chemical Advisers to the Department report that the total number of samples examined during 1916 amounted to 306 only, about the same as in 1915. The total number (53) of rejections was fairly normal, but the number (35) of rejections for faulty composition was somewhat high. This is, no doubt, partly due to the increased complexity of permitted explosives as a whole, but also, possibly, to some extent because, owing to war work, the manufacturers have not the time for quite such careful supervision of blasting explosives as before. The use of sodium nitrate in the place of potassium nitrate still appears to be causing some difficulty in connection with the heat test, but not to such an extent as last year. The number of new explosives examined (15) was the smallest for a good many years, and consequently the number of samples examined in connection with the Home Office Testing Station was also very low.

The total number of accidents with explosives reported during the year is 641, as compared with 485 for 1915. Of these, 363 occurred in manufacture, causing 195 deaths and injuries to 598 persons; no less than 144 deaths were due to two accidents, namely, 106 in one accident on April 2, and 38 in another on Aug. 21. Of the remaining 51, seven were killed at the Roburite Works on May 15, and seven at the Rainham factory on Sept. 14, and it is hardly too much to say that all these 158 fatalities might have been avoided if, instead of engaging in futile efforts to extinguish the fires, the factory officials concerned had cleared everyone away from the neighborhood. Of the 363 accidents, 146

caused no loss of life or bodily injury, and of those injured a very large proportion received very trifling wounds.

In connection with the conveyance of cordite paste from one factory to another, a proposal was made by those chiefly interested that, instead of being packed in wooden barrels, this material should be forwarded in packages, each consisting of a double bag, the outer one being of stout canvas and the inner of a waterproof insertion material. The reasons given for this suggestion were, first, that barrels are now difficult to obtain, and, secondly, that after arrival at the factory, the barrels are the more dangerous to handle in contact with the very dusty explosive. The question was very carefully considered with special regard to the danger of freezing in cold weather, and it has been finally arranged that the vans in which this material is consigned by rail shall be steam-heated under conditions which will eliminate all danger from overheating, and this arrangement appears to give satisfaction.

In November, Messrs. Dupré carried out some tests to ascertain whether the addition of 2 or 3 per cent of moisture to a fulminate composition would appreciably diminish its sensitiveness and render it safer for filling detonators than the dry composition. The results of their experiments indicated that the addition of as much as 5 per cent of moisture to a mixture of fulminate of mercury and potassium chlorate gives no practical increase of safety either against explosion by shock or communication of the explosion of a portion of the mixture to the remainder, and that such mixtures should be treated with the same precautions as are usual when dealing with dry fulminate composition.

Iron and Steel

Steel for Aeroplanes.—In a paper read before the English Aeronautical Society, Dr. W. H. HATFIELD discussed the subject of steel for aeronautical work. An abstract of the paper is given in *The Jr. Soc. Chem. Ind.*, July 16, 1917. Dr. Hatfield emphasized the importance of using high-class material and of employing scientific methods in works practice. Accurate heat-treatment, based on the thermal phenomena associated with each steel, is essential, and this necessitates in works practice the use of satisfactory and properly standardized pyrometers. The best types of furnace, efficiently constructed and worked, are also required if homogeneous results are to be anticipated in the final product.

Though it has often been pointed out that the term "factor of safety" is misleading, yet its erroneous use continues. A true "factor of safety" should be the ratio between the stress which may be safely applied indefinitely under the actual working conditions to the stress actually employed. The actual values of this factor employed in modern design have been arrived at largely by the method of trial. Better results might be obtained, and fewer mysterious failures result, if the various contingencies to be allowed for were carefully examined and the "factor" placed on a more definite basis.

Among these contingencies is low elastic limit as compared with maximum stress. The difficulty of measuring the true elastic limit militates against this fundamentally important figure being determined as frequently as it should be. Our ignorance as regards the properties of steels below the yield-point is considerable, while of the properties between the yield and the breaking stress it is still greater. Variation of temperature, too, has a marked influence upon the physical properties of steel, and the influence of the ranges of temperature to which the parts have to be submitted in practice should be carefully studied. Corrosion might be carefully and profitably considered, particularly as regards seaplanes. Other items which require attention are the internal stresses left after forging and probably also after heat-treatment, and non-uniformity of material, especially as regards conditions produced by unskillful methods of manufacture and heat-treatment. Inclusions of slag, exaggerated sulphide inclusions, defects caused by unsatisfactory treatment in the forge, and last, but not least, hardening cracks, are also extremely important.

Parts not subjected to shock should be produced from material having a high elastic limit with just sufficient ductility to insure non-brittleness, whereas for parts subjected to severe shock toughness is the more important feature. The division between these two classes of stresses is not very sharp, and in many cases a compromise would appear to have been made between two types of material. All the parts under consideration are of relatively small section, and lend themselves to very careful heat-treatment.

There is such wide divergence of opinion as to the best constructional material for pistons that cast-iron, steel, and even aluminium alloys are all in use at the present time. The author records having had definite indication that piston-heads had spent a considerable time in service above the critical point, 730 deg. C. Generally speaking, the fluctuations of temperature during a cycle of operations take place too rapidly for such changes materially to affect the temperature of the piston or cylinder walls, except just at the skin of the material. The possibility of attainment of extremely high local temperatures at the skin depends largely on the thermal conductivity and specific heat of the material, high values in these tending to reduce the fluctuation in temperature.

For many steels the yield-point is not a definite value. If yield-point is to be taken as a guide as to the value of "true elastic limit," and if elastic limit is to be taken as the basis of design, then this quantity must have much more attention than it usually receives.

The use of impact tests of the Izod and Charpy type is not justified in view of the anomalous results obtained in practice. The torsion test is of particular interest to aero engineers, since any shaft which transmits power suffers torsion, and the natural way of testing the strength of such a shaft or of the material of which it is made should be by torsion.

In discussing the properties of a number of typical steels used in aero work, the author described air-hardening steels as extremely important, and predicted that when they are more completely understood they will be used to a much greater extent than at present. An air-hardening steel heated to temperatures of 800 deg. to 850 deg. C. and allowed to cool in air will have great hardness, whereas the hardness introduced by the same treatment in an ordinary carbon or even a high-tensile steel is in no way comparable. It is the presence of a high percentage of nickel, as well as chromium, that induces the specific property. Such steel, on air-hardening from 800 deg. to 850 deg. C., gives 100 tons per

square inch maximum stress and upward, accompanied by an elongation in the neighborhood of 10 per cent. Such results should be extremely valuable to engineers designing aircraft parts. "Stainless steel," a low carbon steel with 11 to 15 per cent of chromium, is air-hardening, and has the property of successfully resisting the ordinary corrosive action of the weather, change from wet to dry atmospheric conditions, organic acids, oxidizing influences, and sea-water. It should, therefore, have a large application to sea-plane work. At present it is used for aero valves, and would appear to be a possible material for stream-line wires.

A considerable tonnage of sheet steel is employed in aero work, *e.g.*, for manufacturing clips, etc. The steel used for such purposes has usually a low tensile strength, say, 28-30 tons. A higher class of sheet steel is being used containing nickel, which gives approximately 35 tons tensile with a considerably higher yield-point than the mild steel. A drawback against this latter steel is that there is some difficulty in working it.

Recent Metallurgical and Chemical Patents

Iron and Steel

Extraction and Recovery of Impurities in Iron Ore.—A process peculiarly, though not exclusively, adapted to the soft iron ores of Cuba, is patented by FREDERIC A. EUSTIS of Milton, Mass. The object of the process is the extraction and recovery of aluminium, nickel, cobalt, manganese and chromium which occur incidentally in the ore, at the same time improving the quality of the iron ore. According to earlier patents of the inventor (1,212,334 and 1,230,143), the object is accomplished by a preliminary heat treatment of the ore in a rotary kiln or hearth roaster, with SO_2 gas at 460° C., followed by dissolution in dilute sulphuric acid or water at 100° C. The aluminium, nickel, etc., go into solution and may be recovered by suitable means of precipitation. While this method is effective, the inventor has discovered that the process can be improved by removing the aluminium from the ore before subjecting it to the sulphating roast. This increases the extraction and recovery of the alumina and makes easier the subsequent reduction of the iron ore.

In carrying out the improved process the ore is first subjected to boiling treatment with strong sodium or potassium hydroxide, dissolving the aluminium compounds, or a substantial part of them, after which the solution is withdrawn and precipitated by aluminium hydroxide. This method regenerates the original precipitant. Or, precipitation can be accomplished with an acid. After this treatment, the original ore is then subjected to the sulphating roast to render soluble the balance of the aluminium and such incidental metals as may be contained. The sulphating roast can be produced by mixing with the ore from 5 per cent to 10 per cent of its weight of pyrite, and heating to 460° C., or the same effect can be produced by treatment with SO_2 gas and air as described above. (1,237,765, Aug. 21, 1917.)

Sintering Finely Divided Iron-Bearing Material.—A contribution to the methods of sintering or clinkering finely divided iron ore, blast-furnace flue-dust, concentrate or other similar material, in order better to fit it for treatment in the blast-furnace, is made in a process patented by FREDERICK W. YOST of Chicago. The process consists in subjecting the material, intermittently or continuously, to roasting or calcination by means of a current of reaction-supporting furnace gas conducted through the mass, the surface of which is heated during the period of reaction. As applied to finely divided iron oxide, the material is mixed with powdered fuel and charged onto the grate of a suitable furnace. Flame or furnace gas, produced from any fuel adapted to the purpose, is brought into contact with the mass surface, and part or all of the gas is drawn downward through the charge. The material is heated uniformly and progressively from top to bottom, and the clinkering reaction initiated at the upper surface is propagated downward through the charge, but at a slower rate than the progress of the heating zone. The process may be applied to the clinkering of cement materials. (1,231,831, July 3, 1917.)

Gold and Silver

Extraction of Gold and Silver from Ore Containing Manganese Dioxide.—According to the specifications of a patent granted to MARTINUS H. CARON of Weltevreden, Java, Dutch East India, the customary low extraction of silver from a gold-silver ore containing large quantities of manganese dioxide, are avoided by a preliminary reducing roast, using CO gas or other reducing agent in the operation. The effect is said to be beneficial for either cyanidation or amalgamation, yielding a silver recovery varying from 93 per cent to 99 per cent. The highest extractions are obtained from ores containing the largest quantities of silver. (1,232,216, July 3, 1917.)

Oil Flotation in Cyanide Solution.—A combination of oil flotation with the cyanide process is patented by JOHN M. TIPPETT of Colorado Springs, Colo. The object of the process is not only the recovery of the precious metals, but also any base metals which may be in the ore. The scheme is applicable to gold and silver ores in general, but particularly to those of the Cripple Creek district, Colorado. The crushed and ground ore is mixed with cyanide solution in equal quantities, the strength of the solution varying with the ore to be treated, from one-quarter of a pound to four pounds of cyanide per ton of water. The mixture is then ground in a suitable mill, the acidity of the ore being neutralized by the addition of suitable alkali, preferably NaOH. The addition of this material is of assistance in effecting subsequent flotation. A suitable flotation oil also is added to the pulp as it flows into the grinding mill, where a thorough mixing takes place. After the pulp issues from the mill it receives an addition of cyanide solution, making the ratio of ore to solution 1:3 or 1:4. The mixture is then conducted to a pneumatic flotation cell, such as the Callow, where the richest and finest minerals are floated and recovered. This mineral is most difficult to recover on concentrating tables as well as most refractory to cyanide solution. The flotation tailing is run over concentrating tables for the recovery of the coarser particles of mineral which escape flotation, and the table tailing, in turn is thickened and agitated in the customary manner for dissolution of the gold and recovery of the pregnant solution. (1,236,501, Aug. 14, 1917.)

Continuous Agitation and Decantation of Slime Pulp.—A method for automatically controlling the continuous agitation and transfer of slime pulp in cyanidation or other hydrometallurgical process is the sub-

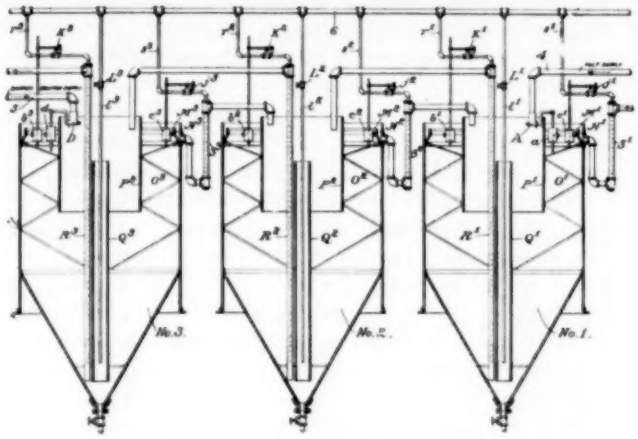


FIG. 1—AUTOMATIC CONTROL IN CONTINUOUS AGITATION AND TRANSFER OF CYANIDE PULP

ject of a patent granted to JOHN W. BUCHER and RANDALL P. AKINS of Denver, Colo., and by them assigned to the Colorado Iron Works Co. of Denver. The system is shown in sectional elevation in Fig. 1. It comprises a series of automatically operated controlling valves for regulating the transfer of the pulp from one agitation tank to the next, and for simultaneously regulating the transfer of a counter-current of barren solution through the tanks in an opposite direction to the flow of pulp. Fig. 1 shows three agitation tanks, 1, 2 and 3, provided with centrally located annular skirts P^1, P^2 and P^3, forming inclosed portions in which the pulp can be agitated and providing outer annular settling spaces O^1, O^2 and O^3, in which clear solution can remain practically undisturbed, ultimately flowing through weirs M^1, M^2 and M^3 into launders N^1, N^2 and N^3, extending around the circumference of the tank. Pulp flows into the right-hand tank through pipe 4, and barren solution into the left-hand tank through pipe 5. Compressed air is supplied through the header 6, from which it is conducted by branch pipes to the places where it is used for agitation and elevation of the pulp. The pulp is thus transferred from one tank to the next through pipes R^1, R^2 and R^3, air being supplied through pipes r^1, r^2 and r^3, each of which has a controlling valve, K^1, K^2 and K^3, respectively, automatically operated by floats b^1, b^2 and b^3. A similar set of solution transfer pipes S^1, S^2 and S^3 are provided, extending from the launder at the top of one tank to the space inclosed by the annular skirt in the next. Air for lifting is supplied by appropriate pipes, each provided with its controlling valve automatically operated by its float.

The operation of the device is as follows: If for any reason the pulp supply should diminish, the level of the solution in the annular space O^1 would tend to fall, thereby lowering the float a and floats b^1, b^2 and b^3, thereby tending to open the supply valve A and close the valves K^1, K^2 and K^3, shutting off the air supply and diminishing the amount of pulp transferred. Should the pulp supply increase, for any reason, the tendency would be to reverse the operation of the device and increase the amount of pulp transferred until equilibrium was restored. Similar reasoning applies to the counter-current transfer of solution. Should the air supply cease suddenly, the air-lifts would stop operating, the solution would rise above the weirs and automatically close the valves A and D, shutting off supplies of pulp and barren solution. The counter-current of barren solution lowers the value of the resulting solution by dilution, and of the remaining pulp by further dissolution of valuable metal. (1,219,240, March 13, 1917.)

Copper, Lead and Zinc

Hydrometallurgical apparatus for the recovery of copper by precipitation of the metal from neutral solution by sulphur dioxide is patented by EDWARD R. WEIDLEIN of Thompson, Nevada, and assigned by him to the Metals Research Co. of New York. The patent specifications relate to the process as developed by Mr. Weidlein at the smelter of the Mason Valley Mines Co., Thompson, Nevada. This process was described in METALLURGICAL AND CHEMICAL ENGINEERING, Oct. 1, 1915, page 652. The chemistry of the process consists in dissolving copper from copper-bearing material with sulphuric acid, and precipitation of the metal from this solution by treatment with sulphur dioxide at a suitable pressure and temperature. The precipitation is accomplished according to the reversible reaction

$$CuSO_4 + SO_2 + 2H_2O = Cu + 2H_2SO_4.$$

The ore is leached with a 3.6 per cent solution of sulphuric acid. The free acid is then neutralized, and the solution containing about 1.5 per cent copper is mixed with approximately an equal amount of sulphur dioxide and then heated to a temperature of about 150° C. at a

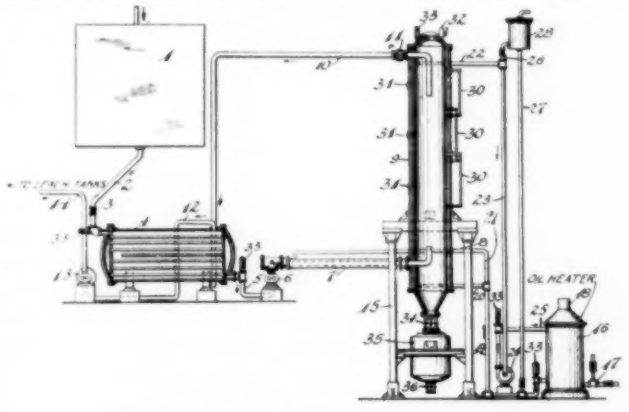


FIG. 2—HYDROMETALLURGY OF COPPER

pressure of 100 lb. per sq. in. Copper is thus precipitated substantially quantitatively and a leaching solution is regenerated.

Apparatus for this process is shown diagrammatically in Fig. 2, consisting of a tank 1 for storage of copper sulphate solution after it has been neutralized and charged with sulphur dioxide; a heat interchanger 4 in which heat from the precipitated solution flowing from the precipitating tank 9 is used to preheat the pregnant solution flowing to the precipitator; an oil heater 16 in which oil is heated for circulation around the precipitator to keep the contents at a temperature of 150° C.; and suitable accessory apparatus in the form of pumps, oil-expansion tank, etc.

In operation, the prepared copper sulphate solution, containing about 1.5 per cent copper and an equivalent amount of sulphur dioxide, is passed through the heat interchanger where it is preheated by the hot precipitated liquor coming from the top of the precipitating tank. The preheated pregnant solution is then pumped under suitable pressure through the oil-jacketed pipe 7 where it is further heated before entering the precipitator. The precipitation of the copper is accompanied

by the regeneration of twice as much sulphuric acid, theoretically, as required for extracting a corresponding amount of copper, as shown in reaction given above. The regenerated solution is then passed through the heat interchanger, where it preheats the solution passing to the precipitator and where it is itself cooled from 150° C. to about 90° C. and again used as a leach liquor. When a precipitator is constructed 3 ft. in diameter and 20 ft. high, having a capacity of about 1000 gal. of solution, it is possible to handle from 50,000 to 100,000 gal. of solution in 24 hours, the operation being practically continuous. (1,223,454, Apr. 24, 1917.)

Furnace for Purifying Zinc from Lead and Iron.—A furnace for the treatment of impure zinc and the separate recovery of pure zinc and such impurities as lead and iron is patented by Richard Ziesing, and assigned by him to the Grasselli Chemical Co. of Cleveland, O. A representation of the furnace is given in Fig. 3. It

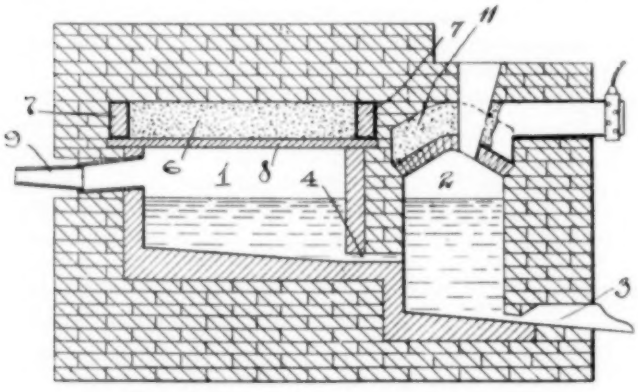


FIG. 3—FURNACE FOR PURIFICATION OF ZINC

consists of two chambers 1 and 2, arranged as shown and connected by a passage 4. Chamber 2 has a charge opening at the top and a drainage conduit 3 at the bottom. Chamber 1 has but one opening at 9, through which the purified zinc is passed to a suitable condensing apparatus. The furnace may be heated in any preferred manner, but is here shown as being heated by electrical resistance elements placed in the roofs of the two chambers at 6 and 11. In starting operations, crude metal is charged into chamber 2 and is there heated until the level of the molten metal approximates that shown in the illustration. Heat is then applied in full force in both chambers, and the metal in chamber 1 is continuously distilled, being collected in a condenser. As fast as zinc is removed by distillation, the charge is replenished in chamber 2. The impurities, lead and iron, being heavier than zinc, tend to collect at the bottom of the chambers. When the accumulation is so great as to affect the purity of the distilled zinc, lead and iron can be drawn from the furnace through the discharge 3. When this operation is about to be performed, the temperature in the furnace is dropped to about 450° C., or slightly above the melting point of zinc. (1,237,141, Aug. 14, 1917.)

Flotation

Selective Separation of Oxidized Ores by Flotation.—An improvement in the selective or fractional separation of oxidized mineral constituents of an ore by means of flotation is patented by Raymond F. Bacon of Pittsburgh, Pa., and by him assigned to the Metals Recovery Co. of New York. The process is applicable to ores containing acid-soluble and acid-insoluble constituents, the latter, however, being convertible into sulphides by treatment with hydrogen sulphide or other soluble sulphide. Whence, by treatment of such an ore with acid and a soluble sulphide, the acid-soluble constituents will go into solution and the sulphide will convert the acid-insoluble minerals into sulphides. Oxidized ores can be treated direct, but some sulphide ores may require a preliminary roast to convert the minerals into a form more readily amenable to the process.

In the latter case, for example, zinc-lead sulphides existing in intimate physical combination may require a roast in order to facilitate the extraction of zinc as an acid-soluble sulphide and convert or complete the conversion of the lead into lead sulphide which is acid-insoluble. Similarly, copper-iron sulphides may require a roast to yield a product in which the original iron sulphide is converted into an acid-soluble sulphide, while the oxidized and dissolved copper will be sulphidized because of the insolubility of copper sulphide in acids. The sulphidation, as well as the solution of the soluble constituents, will occur simultaneously.

When the sulphidation and solution reactions are completed, the ore is subjected to flotation to effect the removal of the sulphides. This separates the insoluble sulphides from the acid-soluble metals, and after flotation the latter can be separated by flotation treatment by first converting them into sulphides after neutralization of the excess acid. An alkaline sulphide can be used for this neutralization. (1,235,954, Aug. 7, 1917.)

Sulphidizing Oxidized Ores for Flotation.—An improvement in preparing oxidized ores for flotation by converting them into sulphides through treatment with hydrogen sulphide, is patented by George D. Van Arsdale of New York City. An obstacle hitherto encountered in sulphidizing copper oxide ores with hydrogen sulphide has been the difficulty of ascertaining the exact amount of hydrogen sulphide necessary, and the avoidance of a deleterious excess. The present invention resides in the discovery that the proper amount of hydrogen sulphide is that required to convert all the copper oxide to sulphide, together with an additional amount of the reagent not in excess of the amount that can be absorbed and neutralized by the pulp; and of the further fact that such excess, which hitherto has been found detrimental, may be rendered harmless by allowing a certain amount of time for its absorption and neutralization. The necessary steps in the operation are: 1. Generation of the hydrogen sulphide. 2. Absorption of the reagent by the pulp. 3. Time of standing. 4. Flotation. Hydrogen sulphide can be generated by the action of acid on low-grade copper matte. The gas can then be brought into contact with the pulp in a suitable agitation vessel, and after this treatment the pulp can be transferred to another vessel, where it may be allowed to stand for the complete absorption of the gas. Usually from two to four hours' time will be found sufficient for this step, after which the pulp may be treated by flotation. (1,236,504, Aug. 14, 1917.)

Electric Furnace Developments at Sheffield, England

In view of the large amount of munition work now being done in this country and the accumulation of borings that is likely to result, the experience of British

steelmakers as given in the following extract from the *Sheffield Telegraph*, Aug. 28, should prove interesting:

The abnormal demand for munitions has, perhaps, done more than anything else could have done towards breaking down the prejudice against electric steel. Before the war had been in progress many months our armament makers found themselves accumulating enormous quantities of borings, turnings, screwings, etc., of very high grade steels, containing chrome, nickel and other costly alloys. In ordinary times these turnings were of comparatively little value on account of the difficulty of remelting them without the loss of most of the alloys. But when the quantities of turnings produced in munition making became abnormal, it was at once realized that the best solution of the problem of utilisation was afforded by the electric furnace, because it was capable of saving all the nickel and almost all the chrome, whilst remelting the scrap, besides which it could, if necessary, oxidise the chrome whilst retaining the nickel. Admittedly, no type of electric furnace was exactly perfect; but with a view to further perfection in the matter of treating these turnings, certain Sheffield metallurgists set to work in earnest to see what could be done to meet the new conditions. This resulted in the development of the furnace known as the Greaves-Etchells furnace, by Messrs. Greaves and Etchells, both of Sheffield.

The number of electric furnaces in Sheffield now built, or building, is about forty, with every probability of a further increase. Turnings, borings, etc., are being converted into steel for shells, rifle barrels, light armour plates, and aircraft. Until the introduction of the electric furnace, there was no type that could melt more than a somewhat limited proportion of turnings per heat. It was necessary to use a large percentage of new raw materials, such as pig-iron, bar-iron, etc., along with the scrap. Now not only is it possible to have a whole heat of turnings, but to have "boils" of ten and even fifteen tons, by the electric process, whereas prior to the war few electric furnaces were of more than 2½ tons capacity. Now these larger furnaces can make sound steel direct from turnings, and at less cost than by the crucible process. The introduction of this type of furnace is, perhaps, one of the most outstanding features of war-time developments in our local industry.

Mr. Greaves is a local expert electrical engineer, and Mr. Etchells is an expert Sheffield metallurgist. These inventors offer a special furnace of small capacity for the production of high-speed and other tool steels, besides the larger furnace for the melting of turnings.

One advantage of the electric furnace is that it requires less space per unit of output than a crucible steel plant. The initial cost is about the same in the case of the electric furnace as of the coke-fired crucible plant, but the saving in space is important, whilst there is a further marked economy where the electric current can be supplied at a reasonable cost. Electricity is already being generated cheaply, compared with the cost ten or twenty years ago. When we consent to harness the tides, or to utilise the water power latent in our rivers, or scientifically to convert our coal into energy at the mines, and so produce electricity at the lowest possible cost, electric iron smelting and steel melting and refining will probably enter upon a wide avenue of development.

A New High-Frequency Induction Furnace

An interesting development in small electric furnaces has been made by Dr. E. F. Northrup of Princeton University in conjunction with the Pyrolectric Instrument Company of Trenton, N. J., and under the direction of the Ajax Metal Company of Philadelphia, Pa.

The furnace (shown in Fig. 1) uses oscillatory currents for the generation of heat. By the use of a highly effective induction without the interlinkage of a magnetic with an electrical circuit, currents can be set up in the containing crucible in the case of a non-conducting melt, or in the melt itself, if the same has sufficient conductance. It is possible to raise the temperature of a melt in a crucible until its resistance becomes low enough to permit the generation of heat in the substance itself (as in the case of melting glass), after which the temperature producible is limited only by the durability of the insulation and container.

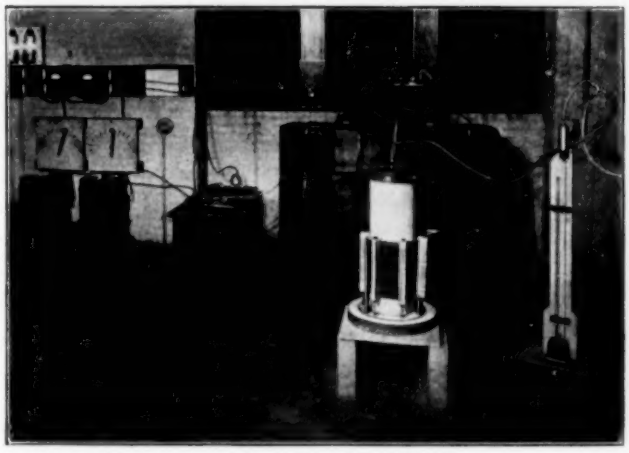


FIG. 1—HIGH-FREQUENCY INDUCTION FURNACE

The furnace is especially suitable for alloy research at temperatures above 1400 deg. C., inasmuch as it makes possible the running of melts in vacuum or in any atmosphere desired, particularly in one free from carbon. With a 20-kw. furnace, which is the largest size so far built, a temperature of 1620 deg. C. has been easily attained. Theoretically there is no temperature limit, but practically there is a limit because of the necessity for proper heat insulation between the containing crucible and the outside coil.

What is actually accomplished is to induce countless eddy currents in the melt itself, providing same is a conducting substance, by the use of oscillating current at a frequency of about 12,000 cycles. If the melt is of a non-conducting substance, such as glass, a conducting crucible such as graphite is used. Eddy currents are then induced in the crucible, which in turn heats the glass, rendering it conducting as it rises in temperature, after which eddy currents are set up in the glass itself.

Increased Exportation of Crude Oil and Petroleum Products

Exports of petroleum and its products from the United States during the twelve months ended June 30, 1917, showed increases in both quantity and value over the preceding twelve-month period. The increases in value were proportionately greater than the increases in quantity. The most noteworthy increases were those in exports of gasoline and naphthas, which increased 44 per cent in quantity and 92 per cent in value. Exports of lubricating oil showed a large increase in value as compared with the increase in quantity. The following table shows the quantity and value of petroleum and its products exported during the fiscal year ended June 30, 1917, as compared with the previous year.

		12 Months Ending June 30—		Per Cent of Increase
		1917	1916	
Illuminating oil	gallons	835,114,403	823,143,138	1
	value	$54,662,094	$52,283,057	4
Gasoline and naphthas,	gallons	425,703,130	294,779,809	44
	value	$87,971,263	$45,770,274	92
Lubricating	gallons	271,028,546	250,395,439	8
	value	$48,649,557	$37,452,084	29
Residuum products	gallons	1,041,223,680	911,397,068	14
	value	$32,507,685	$25,157,423	29
Crude oil	gallons	176,368,675	163,732,589	7
	value	$7,162,550	$5,754,084	24
Totals	gallons	2,749,438,434	2,443,448,043	16
	value	$230,953,149	$166,416,922	38

Temperature Indicator for Electrical Machines

Many parts of the dynamos and motors used in generating and using electrical power are quite inaccessible to thermometers, although frequently subject to dangerous overheat. To overcome this condition in the larger capacity machines, and also to provide means of warning operators stationed at a distance from their dynamos of the rising heat, the General Electric Company of Schenectady, N. Y., has developed a temperature indicator for electrical machines which is operated by electricity itself.

This device consists of "feeler coils," connecting wire, a few small switches and a "voltmeter." The feeler coils are placed in the dynamo or motor in parts where overheat is especially feared and are then connected to the "voltmeter" which is really the indicating instrument. When the dynamo "warms up," these coils get warm also, and cause the indicating needle of the voltmeter to move over a scale graduated in degrees centigrade, telling the operator just how "hot" the machine is in the part in which the feeler coil is located.

The "voltmeter" or indicator is mounted on a suitable panel, which may be located any desired distance from the generating dynamo.

An Interesting Flotation Process

One of the very interesting exhibits to the metallurgist at the Chemical Exposition was the Groch flotation machine shown by Groch Centrifugal Flotation, Ltd., Cobalt, Ontario.

The Groch flotation plant consists of a tube mill for grinding ore and an oil flotation machine for recovering the valuable minerals. The ore is fed into the tube-mill, along with a small quantity of water, by means of a revolving scoop and the actual grinding is performed by steel balls or hard flint pebbles in the cylindrical body.

From the tube-mill the ground ore in the form of flowing pulp is fed into the first compartment of the flotation machine by means of a pipe. Here it is sucked into the lower part of the first impeller. A minute quantity of a light oil is dropped through the hollow shaft of this same impeller and, falling into the upper part of the impeller, is atomized and dispersed through the large volume of air which is sucked down simultaneously through the same channel.

The pulp and oiled air are ejected together through the impeller at its periphery. During the process, the most easily floated minerals become smeared with oil while the air performs an action similar to that of blowing soap bubbles. The combination of oil, air and mineral then floats to the surface in the form of a scum and overflows to a suitable receptacle. The residue from this first operation is sucked into the second compartment of the machine and the system of treatment is repeated in the second impellor using the same or different class of oil depending on the ease or difficulty with which the remaining minerals may be recovered.

By this system of oil flotation it is claimed to be possible to recover, by preferential selection, various minerals, each in turn, from a complex ore by using different oils or oil mixtures during treatment.

Personal

Dr. **J. S. Agraz,** director of the School of Chemistry of the National University of Mexico, was an interested visitor at the Chemical Exposition in New York, Sept. 24 to 29.

Mr. **Harry A. Curtis,** now First Lieutenant commanding Troop K, Colorado National Guard and formerly professor of physical chemistry in the University of Colorado, has been ordered to report to the Chief of Ordnance at Washington.

Among the distinguished visitors at the Chemical Exposition held recently in New York, were Lieutenant **Rene Engel,** chemical engineer, and secretary of the Societé de Chimie Industrielle of Paris, and Prof. **Victor Grignard** of the Institut de Chimie de Nancy. Both are members of the French Scientific Mission to the United States.

Mr. **M. J. Falkenburg** of Falkenburg & Laucks, chemists and engineers, Seattle, Wash., is on a trip to Anchorage, Alaska, in the interests of the Alaskan Engineering Commission. Falkenburg & Laucks, through Hildreth & Co. of New York, are inspecting materials of all kinds used in the construction of the Government railway in Alaska.

The Pfaudler Co., Rochester, N. Y., has the following men enlisted in the military service: **Henry R. Allen,** assistant salesmanager, Major Cavalry Officers' Reserve Corps; **Otto I. Chormann,** chief chemist, Major 1st Battalion, 3rd Infantry, N. G. N. Y.; **Charles Hayes,** chemist, Sergeant Co. H, 3rd Infantry, N. G. N. Y.; **Louis Strasner,** erector, private, Co. H. 3rd Infantry, N. G. N. Y.; **George E. Gray,** salesman, Corporal, 1st Infantry, N. G. Illinois; **Gordon Kipp,** draughtsman, private, Co. H, 3rd Infantry, N. G. N. Y.; **Elson I. Wright,** accountant, private, Base Hospital Unit 19, Medical Reserve Corps; **Rodney J. Swetting,** industrial engineer, Lieut. E. O. R. C.

Dr. **Alcan Hirsch** will sail for Japan on Oct. 25 on the steamship Empress of Asia to continue his work as consultant for the Japan Dyestuff Manufacturing Company, which is subsidized by the Japanese Government. Dr. Hirsch expects to be in the Orient three or four months.

Dr. **H. B. North,** associate professor of chemistry at Rutgers College, New Brunswick, N. J., has resigned to become connected with the York Metal & Alloy Company, York, Pa., in the capacity of director of the Research Laboratories.

Dr. **Walter Runge,** formerly connected with the chemical plant of the du Pont Powder Company, Wilmington, Del., has resigned.

The following members of the staff of the Asbestos Protected Metal Co. of Pittsburgh are now in Government service: **Stuart S. Caves,** formerly in engineering department, Officers' Reserve, at Fort Niagara; **F. C. Easterby,** formerly district representative at St. Louis, Constructing Quartermaster, Fort Riley, Kansas; **W. C. Fanning,** formerly in engineering department, Officers' Reserve, Fort Niagara; **William H. Hale,** formerly district representative at Minneapolis, Minn., has completed training, Officers' Reserve; **E. G. Irwin,** formerly district representative at Cincinnati, Ohio, now somewhere in the South with Ohio National Guard Regiment; **J. R. Nichols,** formerly district rep-

resentative at Atlanta, Ga., now Captain of Field Artillery, address, Capital City Club, Atlanta; **John B. Williamson,** formerly in erection department, commissioned First Lieutenant of Engineers, and now in Washington; **Walter A. Slingluff,** formerly in skylight department, enlisted with Pittsburgh Regiment of Engineers, and now somewhere in France; **P. J. Young,** formerly chief engineer, commissioned First Lieutenant of Engineers and now somewhere in France; **T. R. Galey,** formerly district representative at Dallas, Texas, Officers' Reserve, Leon Springs, Texas.

Book Reviews

Chemical Control in Cane Sugar Factories, by **H. C. Prinsen Geerligs.** New York: D. Van Nostrand Co.

The name of Prinsen Geerligs in cane sugar literature is sufficient to command a respectful hearing. A book on the chemical control of cane sugar factories from one who has long been identified with the Java sugar industry and who is recognized as one of the foremost authorities in this field will be of interest to all concerned.

While the present volume is a revision of a book with a similar title published in 1905, it has in its present form almost doubled in size and is largely a new work in many respects. While some may at first be disappointed that it lacks the scholarly character of some of Geerligs' other publications, this is hardly a valid criticism when the purpose for which the book is written is understood. It is intended as a guide and working manual for the "European chemist" who goes to the tropics to take charge of the laboratory of a cane sugar factory with no trained help except that of his native assistants. From the fact that all the methods and calculations and a list of the necessary laboratory equipment are given in such detail, it may also be inferred that the European chemist is frequently a man who lacks experience in cane sugar work.

We hence find that the book is written in the style of a set of directions, with very little theory or discussion, but with all operations described in great detail and with model forms for all the technical reports. The control prescribed is a thorough one, although one wonders that no mention is made of the alpha-naphthol test for condensed waters.

The book is divided into several parts of somewhat unequal length. The first part is of considerable importance because it contains all the sampling and analytical methods. The author's experience enables him to make a wise selection here. The following three parts deal with the determination of actual and calculated weights, with stock taking and with miscellaneous calculations. The impossibility of obtaining an average sample of the cane and the general use of maceration make it necessary to employ a great many indirect methods in calculating weights and percentages. The author's experience and judgment are of value on these questions. An interesting suggestion in connection with unknown losses is contained in the following: "In case the unaccountable losses are too great to be neglected, a record is made in the same way for the solids in order to obtain a good insight into the character of the loss. Chemical losses, occasioned by inversion, souring, superheating, etc., are found in the sucrose account, but not in that of the solids; while mechanical losses, such as spilling, boiling over, etc., are also recorded in both sucrose and solids accounts."

The book is copiously provided with tables. In this, the English edition, the language is not always smooth, and is sometimes even obscure. The book is, of course, written largely from the standpoint of Java practice, but it should be of great value to every cane sugar chemist.

Explosives. By **Arthur Marshall,** A.C.G.I., F.I.C., F.C.S., Chemical Inspector Indian Ordnance Department of Great Britain. Second edition. Two volume. Vols. I, xv and 408 pages; 77 illustrations. Vol. II, ix and 387 pages; 80 illustrations. Price $16. Published by P. Blakiston's Son & Co., 1012 Walnut Street, Philadelphia, Pa.

At no time in the world's history has the manufacture and the use of explosives attained such importance as the present. Before the Great War plants manufacturing several thousands of pounds of smokeless powder a day were considered large; the enormous demand for propellants now requires many plants each of whose output per diem is expressed in hundreds of thousands of pounds. New explosives have been developed to meet new demands or to circumvent a shortage of raw material, and old explosives have been put to new uses. Much useful information and valuable experience has thus been acquired which has not been published.

The daily papers have made us all familiar with such words as picric acid, ammonal and many others, the letters "TNT" have concealed the identity of one of the most used military high explosives. The production of these and other little known chemical compounds have assumed large proportions. We have recently learned the importance of the minute quantity of material contained in the percussion cap.

Not only has the demand for military explosives been great but also larger quantities of commercial explosives have been needed to meet the inflated demand for the products of our mines. Dynamite has been called upon to increase the productivity of the soil.

The knowledge acquired during the last few years has not been published in collected form and much can only be found in technical journals in foreign languages; the first edition of this work has been made somewhat obsolescent by the rapid advance of the art. Marshall's Explosives therefore fills a distinct want as it is by far the most comprehensive work on the subject yet published and is up to date. The whole field is covered with as much detail as is possible in a work of this extent, the amount of space devoted to each subject being well balanced. The man in the industry will broaden his outlook and his lay brother gain authoritative knowledge from these volumes.

Volume I is subtitled "History and Manufacture." The historical part takes about fifty of the four hundred pages. The remaining pages are devoted to the manufacturing process under the following subdivisions: Black Powder, Acids, Nitric Esters of Carbohydrates, Nitric Esters of Glycerine, Nitro-aromatic Compounds, Smokeless Powders and Blasting Explosives. Under Nitro-aromatic Compounds we learn about the manufacture of trinitro-toluene or "TNT," picric acid, etc. Each of these subdivisions is treated

with as much detail as is necessary for a thorough understanding of the manufacturing process described. In writing on the subject of explosives the author is restrained in some instances by the fact that many of the details of these processes cannot be published, also as the author states "Details of manufacture . . . can only be learned properly in the factory." The part on Acids deserves particular attention, the difficult subject of mixed acids, the basis of all nitro-compound manufacture, is well handled.

Volume II is subtitled "Properties and Tests." It is subdivided into Properties of Explosives, Some Special Explosives, etc., Stability, etc., Materials and Their Analysis. There are three appendices.

The subject of "Properties of Explosives" is particularly well treated. The qualities of an explosion are explained together with the tests for and the determination of these qualities. It is the quality of the explosion produced that determines the use to which an explosive is put.

Under the subdivision "Some Special Explosives, etc.," the manufacture and testing of time fuses, shrapnel, hand grenades, commercial high-explosives, coalmine explosives, fireworks, etc., are treated in detail.

Under the subdivision "Materials and Their Analysis," special methods are described for the chemical analysis of practically all of the raw and finished products used or produced in the manufacture of explosives. The analytical methods are well chosen.

The two volumes are extensively and separately indexed both as to subjects and names, making the work quite available for reference. The name index and the copious references in the text constitute a comprehensive bibliography.

CURRENT MARKET REPORTS

Non-Ferrous Metal Market

Friday, Oct. 5.—Copper and lead are unchanged. Tin is off about one cent per pound and spelter is slightly weaker. Silver has had just as sensational a decline as its advance. At the present writing it is quoted at 92⅛. An interesting metal to watch is aluminium which is now down to about 40 cents. Antimony remains unchanged.

Copper.—Since the fixing of the price of copper at 23.50 cents by the Government, producers have declined to quote. Dealers made a few offerings at 26.00-26.50 cents but the market in general has been very dull. Producers are not making any deliveries except on Government orders. The following committee has been appointed to assist the Government in handling the copper situation. C. F. Brooker (chairman), American Brass Company; Barton Haselton, Rome Brass & Copper Company; W. F. Banker, General Electric Company; L. H. Jones, Detroit Copper & Brass Rolling Mill Company; G. P. Miller, Bridgeport Brass Company; A. L. Salt, Western Electric Company; Carl Roebling, J. A. Roebling's Son Company; G. A. Cook, Taunton-New Bedford Copper Company; D. M. Brady, Brady Brass Company; M. H. Howard (secretary), National Conduit & Cable Company.

Tin.—Arrivals in September were small, about 2500 tons. Spot Straits is quoted at 60.75 and No. 1 Chinese at 56.00. The statistics for the month and year as given by the New York Metal Exchange and American Metal Market are as follows:

		Tons.
Arrivals at Atlantic ports amounted to		2,405
Arrivals at Pacific ports		3,302
Total arrivals since Jan. 1, 1917		44,837
Deliveries for September—		
Atlantic ports	2,100	
Pacific ports	3,302	5,402
Total deliveries since Jan. 1, 1917		45,951
Deliveries same period in 1916		44,413
Estimated shipments from Straits		5,000
Against previous month		5,770
Against September, 1916		3,270
Statistics for the United States—		
September 30th, show as follows:		
Stocks, including on dock and landing		2,397
Afloat		5,175
The total statistics for Europe and the United States show:		
Total visible supply Sept. 30, 1917		19,153
Against " Aug. 31, 1917		20,353
" " Sept. 30, 1916		16,192
" " Dec. 31, 1916		20,737

Lead.—There is no change in price from the trust price of 8.00 cents. The buying element has been very small.

Spelter.—Prompt spelter is quoted at 8¼-8½ cents. Brass special is 8.75 St. Louis. The Government has purchased 2,000,000 lb. of Grade "B" at 10.67½. Generally the market has been dull.

The Iron and Steel Market

Since the inception of price fixing in the iron and steel industry the market has been practically inoperative, this condition succeeding to that of stagnation which had obtained for about three months. The meeting at which an agreement between the Government and the producers was reached was held in Washington Sept. 21. The majority opinion in the trade had been that an agreement could not be reached, and even during the progress of the meeting appearances for a time were that a price basis would be adopted by the manufacturers which would be unacceptable to the Administration. The issue was an interesting one. There were three classes of purchases, those by the Government of steel for its own use, those by or for the account of the Government's Allies, and those by the general public. The Administration had the right to fix prices in the first case, but not in the second or third except through further legislation and there was doubt as to the constitutionality of legislation referring to the second case.

In its surface form, the issue was whether the producers would assent to the "one price for all" doctrine of President Wilson, but in practice it became a question what level of prices could be agreed upon. If the prices were made high enough the producers had no ground whatever for objecting to making one price for all. An agreement was reached whereby Lake Superior iron ore prices ruling for the season of 1917 should be continued, pig iron should be priced on a basis of $33 for foundry, malleable and basic at valley furnaces, steel bars should be 2.90c, structural shapes should be 3c and plates shoud be 3.25c. These prices were set merely to form a basis, from which prices for other commodities could be worked out. The pig iron and steel prices are a trifle more than double the average prices in the ten calendar years before the war.

Immediately the producers undertook to agree among themselves upon prices for other commodities which should be in keeping with this price basis, for submission to the War Industries Board, which after final reference to the President will announce prices to the public. There is ground for suspecting that in some cases prices will be submitted by manufacturers which the War Industries Board will have occasion to scale down in order to make them fully in keeping with the adopted basis. One reason for this suspicion is that some of the manufacturers have expressed an altogether untenable theory, that certain prices should be set relatively high, "in order to stimulate production." That would mean, in actual practice, that classes of steel required for prosecuting the war should involve a greater profit than classes of steel not so required, for instance, that there should be a greater profit in making shell steel than in making steel for pleasure automobiles. It is for the Government to find its steel by other methods than by paying premiums.

SYSTEM SATISFACTORY

The system for fixing prices is regarded as eminently satisfactory. It had become fairly well established that if nothing were done voluntarily there would eventually be full legal regulation, undoubtedly with much inequity and certainly with a degree of rigidity that would not conduce to smooth operation. The system is that of the Government accepting a basis which promises to afford a certain volume of profits to the producers, about half of which will pass to the Government in the form of taxes, only a small part of the total profits being the profits on Government orders that remain in the hands of producers. The producers arrange details quite largely, as to relative prices, extras, etc., all under the full supervision of the authorities at Washington, and room is left for the Government to require a reduction after Jan. 1, 1918.

The regulation of sequence in which orders are to be filled, by the Priority Board, is accepted by the producers without so much as a remark. The Priority Board is a subsidiary of the War Industries Board, which has general charge of the making of purchases, both for the Government and for its Allies.

MARKET WILL BE QUIET

The quiet market now being experienced is not merely contemporaneous with the period of price uncertainty, while the full schedule of prices is being developed. The original price agreement, covering iron ore, certain descriptions of pig iron in one district, that go at the one price of $33, and the steel products bars, shapes and plates, hardly count as more than five items, yet it was announced immediately after this agreement that the War Industries Board contemplated fixing prices on about 150 articles of steel. Thus the program is quite extensive and it will certainly be weeks before the entire price list is made out. Then the period of price uncertainty will be ended, and the various market prices previously prevailing will have disappeared.

The quiet market, however, is likely to continue for some time thereafter, perhaps for the duration of the war. There are two incentives to forward buying, one being a prospect that prices will advance. That prospect is now absent. It seems to be the general opinion that if prices are vised after once being fixed they will be revised downward. The second incentive is to secure a place on order books so as to insure delivery before delivery occurs against orders that others may place later. The Priority Board has announced that it will decree deliveries in sequence according to three classifications, material required for war, material not for war but indirectly helping the prosecution of war, and all other. The ordinary buyer does not know how much material there will be in the first category, nor how much will find itself in the second category nor, as a rule, whether his material will be included in the second or the third. Hence, when the mills are already filled with orders representing their output for months to come he can have no idea when delivery would be made against his order. Delivery might be delayed to a time when it would be altogether inconvenient to receive the material. The producer on the other hand could hardly regard the order as doing more than increasing the clutter in his order books. Hence neither buyer nor seller will be much disposed to transact business until the volume of business on books is greatly reduced. There will be a transitionary period, during which much more steel will be shipped than ordered.

Buying of war material promises to be heavy, particularly in the next couple of months. Not only will orders for the Government be placed somewhat more freely, but the large volume of business for account of the Government's Allies, which has been accumulating for months, will be let loose, now that the question has been settled what prices the Allies are to pay. Immediately after the price agreement was reached an eminent authority estimated that the tonnage to be placed in two months would amount to 7,000,000 tons, chiefly, it appears, for delivery in 1918. This would represent a trifle more than 20 per cent of a year's output at the present rate of production, but a trifle less than 20 per cent of a year's output if all capacity were fully engaged, a condition that has not existed for the past ten months, on account of the shortage of coke. As some war steel has already been ordered that will not be delivered until 1918 and as additional orders will follow the placing of those now in immediate contemplation, the total of war steel will probably exceed 30 per cent of the productive capacity. While the remainder appears large, particularly in view of the increased and increasing capacity, steel is certain not to be plentiful in all forms if in any. The rolling industry is highly specialized and the alignment of capacity in the different finishing departments is not in accordance with the peculiar needs of the war.

Chemical Market

COAL TAR PRODUCTS.—The general position of these markets continues more or less quiet, and some items are somewhat easier for the fortnight.

Benzol.—The market is quite far from firm and values are rather lower than the situation seemingly warrants. However, supplies appear to be quite ample at most points.

Aniline Oil.—There is a better feeling prevalent in the aniline oil trade at present, although but comparatively unimportant business is being transacted. The

business is rather restricted owing to the fact that some holders will not release the oil at present prices.

Paranitraniline.—Business remains substantially the same and the demand has not improved perceptibly. A few important inquiries, however, have been noted lately. Production is now much restricted.

Metanitraniline.—This product is being made by a few manufacturers, but difficulties have kept the production low and the steady consuming demand makes for a limited offering.

Monochlorbenzol.—Difficulties in moving supplies are indicated in reports from various sources and prices have been subject to sharp declines for certain brands.

Dinitrochlorbenzol.—Demand is not very heavy and prices are not particularly strong, and an increased production has been noted which has not been attended by a broader demand.

Toluol.—With about 95 per cent of the production going into the manufacture of explosives, and makers working in many cases to capacity to take care of Government requirements in the manufacture of T.N.T., a firm tone is shown in this market. Prices, however, remain firm and are about the same as heretofore.

Dinitrotoluol.—The output has not increased to any extent and producers have little difficulty in selling their product.

Toluidenes.—Demand is not particularly heavy and prices are firmly maintained. Para is strong and active with ortho moving fairly well.

Naphthalene.—A firmer market seems to prevail and considerable material changed hands on a firm basis. Supplies are light and are not being augmented to any extent.

Phenol.—The situation seems to be gradually favoring the large manufacturer, who is slowly coming into his own. The small producer has been eliminated to some extent and the stronger hands now have the situation under better control than for more than a year past.

Dinitrophenol.—This product has been in better request for a while past and sellers are quoting at prices which are more firm.

Para-amidophenol.—There is a fairly good demand for this product and manufacturers are experiencing a fairly steady business, but production is increasing heavily. For the hydrochloride prices are about at same levels.

Heavy Chemicals.—A sharp break in caustic soda on Oct. 1 resulted in the gradual slowing up of business under this classification and at present business is quite unsettled, with difficulty experienced in securing export permits.

Caustic Soda.—There has been a pronounced drop owing to the embargo placed by the Government, effective Oct. 1, 1917, which absolutely prohibits the exportation of this product, and it is thought the purpose of this embargo is that of conservation rather than for preventing this material from entering the enemies' countries. Somewhat of a recovery, however, has been noted in the market and but little business is passing.

Soda Ash.—In view of the uncertainty created by the drop in caustic it is quite difficult to reflect accurate conditions. Business is somewhat uncertain and is at present hanging fire.

Bleaching Powder.—This market has been absolutely neglected and prices have dropped to the level which prevailed prior to the war. Stocks are large and buyers are showing no interest.

Cyanides.—The market at the present writing is somewhat easier and there are more liberal offers of the soda and the mixture. The potash is particularly scarce, however, and but little is offered in this market.

Silicate of Soda.—This situation is in about the same condition, supplies of 60 deg. material being very limited and no supplies of any importance are to be had.

Bichromate of Soda.—Very little change is noted in the last fortnight and prices remain about the same.

Bichromate of Potash.—There is a fairly good tone noted in the market and prices have been firmly maintained.

Chlorates.—There is little change noted in this situation either in the potash or soda, and prices range about the same.

Copper Sulphate.—Quite a flurry was reported recently, and it is thought possible that this will prove the beginning of large purchases for export.

Arsenic White.—There is an excellent demand for this product and sellers continue to get good prices.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET OCT. 5, 1917

Acetic anhydride	lb.	1.90	—	2.00
Acetone, drums	lb.	.35	—	.36
Acid, acetic, 28 per cent	lb.	.06	—	.06½
Acetic, 56 per cent	lb.	.11	—	.13
Acetic, glacial, 99½ per cent, carboys	lb.	.37	—	.38
Boric, crystals	lb.	.13½	—	.14
Citric, crystals	lb.	.70	—	.72
Hydrochloric, commercial, 18 deg	lb.	.02½	—	.02¼
Hydrochloric, 20 deg	lb.	.02½	—	.02¾
Hydrochloric, C.P., conc., 22 deg	lb.	.02¾	—	.02⅞
Hydrofluoric, 30 per cent, in barrels	lb.	.06	—	.06½
Lactic, 44 per cent	lb.	.11	—	.12
Lactic, 22 per cent	lb.	.05	—	.05½
Nitric, 36 deg	lb.	.07¾	—	.07⅞
Nitric, 42 deg	lb.	.08	—	.09
Oxalic, crystals	lb.	.45	—	.46
Phosphoric, 85 per cent	lb.	.35	—	.39
Picric	lb.	.70	—	.75
Pyrogallic, resublimed	lb.	3.10	—	3.15
Sulphuric, 60 deg	ton	27.00	—	30.00
Sulphuric, 66 deg	ton	35.00	—	36.00
Sulphuric, oleum (Fuming), tank cars	ton	45.00	—	
Tannic, U. S. P., bulk	lb.	1.25	—	1.40
Tartaric, crystals	lb.	.78½	—	.79
Alcohol, grain, 188 proof	gal.	4.30	—	4.35
Alcohol, wood, 95 per cent	gal.	1.10	—	1.12
Alcohol, denatured, 180 proof	gal.	.95	—	1.00
Alum, ammonia lump	lb.	.04¼	—	.04½
Alum, chrome ammonium	lb.	.18½	—	.19
Alum, chrome potassium	lb.	.23	—	.24
Alum, chrome sodium	lb.	.12½	—	.13
Alum, potash lump	lb.	.09	—	.09½
Aluminium sulphate, technical	lb.	.02	—	.02½
Aluminium sulphate, iron free	lb.	.03¼	—	.03½
Ammonia aqua, 26 deg. carboys	lb.	.13	—	.14
Ammonium carbonate	lb.	.12½	—	.13
Ammonium nitrate	lb.	.22	—	.24
Ammonium, sulphate domestic	lb.	.7	—	.07⅛
Amyl acetate	gal.	4.50	—	4.60
Arsenic, white	lb.	.16	—	.16½
Arsenic, red	lb.	.65	—	.70
Barium carbonate, 99 per cent	ton	70.00	—	
Barium carbonate 97-98 per cent	ton	65.00	—	
Barium chloride	ton	70.00	—	80.00
Barium sulphate (Blanc Fixe, powder)	lb.	.04	—	.04½
Barium nitrate	lb.	.10	—	.11
Barium peroxide, basis 70 per cent	lb.	.27	—	.27½
Bleaching powder, 35 per cent chlorine	lb.	.01¼	—	.01½
Borax, crystals, sacks	lb.	.07¼	—	.07½
Brimstone, crude	ton	60.00	—	65.00
Bromine, technical	lb.	.70	—	.80
Calcium, acetate, crude	lb.	.06	—	.06⅛
Calcium, carbide	lb.	.08½	—	.09
Calcium chloride, 70-75 per cent, fused, lump	ton	36.00	—	38.00
Calcium peroxide	lb.	1.60	—	1.70
Calcium phosphate	lb.	.30	—	.31
Calcium sulphate	lb.		—	
Carbon bisulphide	lb.	.07	—	.07½
Carbon tetrachloride, drums	lb.	.16½	—	.16¾
Caustic potash, 88-92 per cent	lb.	.85	—	.87
Caustic soda, 76 per cent	lb.	.07¾	—	.08
Chlorine, liquid	lb.	.15	—	.20
Cobalt oxide	lb.	1.40	—	1.50
Copperas	100 lb.	1.02	—	1.07
Copper carbonate	lb.	.30	—	.35
Copper cyanide	lb.	.75	—	.78
Copper sulphate, 99 per cent, large crystals	lb.	.09	—	.09⅛
Cream of tartar, crystals	lb.	.50	—	.52
Epsom salt, bags	100 lb.	4.00	—	4.25
Formaldehyde, 40 per cent	lb.	.16½	—	.17
Glauber's salt	100 lb.	.80	—	.85
Glycerine, bulk, C. P.	lb.	.70	—	.71
Iodine, resublimed	lb.	3.50	—	3.55
Iron oxide	lb.	.13	—	.15

Lead, acetate, white crystals	lb.	.17	—	.17½
Lead arsenate	lb.	.15	—	.18
Lead nitrate	lb.	.17½	—	.18
Litharge, American	lb.	.10½	—	.12¼
Lithium carbonate	lb.	1.50	—	2.00
Manganese dioxide, U. S. P.	lb.	.48	—	.55
Magnesium carbonate, tech.	lb.	.12	—	.13
Nickel salt, single	lb.	.12	—	.....
Nickel salt, double	lb.	.09	—	.....
Phosphorus, red	lb.	1.25	—	1.30
Phosphorus, yellow	lb.	2.15	—	2.20
Potassium bichromate	lb.	.44	—	.45
Potassium bromide granular	lb.	1.35	—	1.40
Potassium carbonate calcined, 80-85 per cent	lb.	.70	—	.75
Potassium chlorate, crystals	lb.	.54	—	.55
Potassium cyanide, 98-99 per cent	lb.	2.60	—	2.70
Potassium iodide	lb.	2.90	—	3.00
Potassium muriate 80-85 p.c. basis of 80 p.c.	ton	325.00	—	350.00
Potassium nitrate	lb.	.28	—	.30
Potassium permanganate	lb.	3.85	—	4.00
Potassium prussiate, red	lb.	2.70	—	2.80
Potassium prussiate, yellow	lb.	1.25	—	1.30
Potassium sulphate, 90-95 p.c. basis 90 p.c.	ton	300.00	—	325.00
Rochelle salts	lb.	.39	—	.39½
Salammoniac, gray gran.	lb.	.10	—	.11½
Salammoniac, white gran.	lb.	.15½	—	.16
Sal soda	100 lb.	1.20	—	1.25
Salt cake	100 lb.	1.10	—	1.15
Silver cyanide, based on market price of silver	oz.	.....	—	.....
Silver nitrate	oz.	.69	—	.71
Soda ash, 58 per cent. light, flat	100 lb.	3.50	—	3.60
Soda ash, 58 per cent, dense, flat	100 lb.	3.90	—	4.00
Sodium acetate	lb.	.11	—	.11½
Sodium benzoate	lb.	1.75	—	2.00
Sodium bicarbonate, domestic	100 lb.	2.45	—	2.50
Sodium bicarbonate, English	lb.	.....	—	.....
Sodium bichromate	lb.	.24	—	.25
Sodium bisulphite, powd.	lb.	.04½	—	.05
Sodium chlorate	lb.	.24	—	.25
Sodium cyanide	lb.	.54	—	.55
Sodium fluoride, commercial	lb.	.18	—	.18½
Sodium hyposulphite	lb.	.01¾	—	.02
Sodium nitrate, 95%	100 lb.	4.90	—	5.00
Sodium nitrite	lb.	.38	—	.40
Sodium peroxide	lb.	.55	—	.60
Sodium phosphate (tri.)	lb.	.04¾	—	.05
Sodium prussiate, yellow	lb.	.36½	—	.37
Sodium silicate, liquid—40 deg. Baumé	100 lb.	2.50	—	2.60
Sodium sulphide, 30 per cent crystals	100 lb.	2.50	—	3.00
Sodium sulphide, 60 per cent, fused	100 lb.	3.75	—	4.00
Sodium sulphite	lb.	.04	—	.05½
Strontium nitrate	lb.	.35	—	.40
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	4.05	—	4.10
Sulphur, roll	100 lb.	3.70	—	3.85
Sulphur, crude	ton	60.00	—	65.00
Tin bichloride, 50 deg.	lb.	.19¾	—	.20
Tin oxide	lb.	.64½	—	.65
Zinc carbonate	lb.	.25	—	.27
Zinc chloride	lb.	.16	—	.17
Zinc cyanide	lb.	.50	—	.....
Zinc dust 350 mesh	lb.	.17	—	.18
Zinc oxide, American process XX	lb.	.15½	—	.16
Zinc sulphate	lb.	.06	—	.06¾

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.50	—	.52
Benzol, 90 per cent.	gal.	.50	—	.52
Toluol, pure water white	gal.	1.80	—	1.85
Xylol, pure, water white	gal.	.45	—	.50
Solvent naphtha, water white	gal.	.18	—	.22
Solvent naphtha, crude, heavy	gal.	.13	—	.16
Creosote oil, 25 per cent	gal.	.33	—	.35
Dip oil, 20 per cent.	gal.	.29	—	.30
Pitch, various grades	ton	8.00	—	20.00
Carbolic acid, crude, 95-97 per cent.	lb.	1.05	—	1.10
Carbolic acid, crude, 50 per cent.	lb.	.60	—	.65
Carbolic acid, crude, 25 per cent.	lb.	.32	—	.35
Cresol, U. S. P.	lb.	.19	—	.20

Intermediates, Etc.

Alpha-naphthylamin	lb.	.62	—	.65
Aniline oil	lb.	.26	—	.28
Aniline salts	lb.	.33	—	.34
Anthracene, 80 per cent.	lb.	.10	—	.....
Benzaldehyde	lb.	4.00	—	4.50
Benzidine, base	lb.	1.60	—	1.80
Benzidine, sulphate	lb.	1.40	—	1.50
Benzoic acid	lb.	1.75	—	2.00
Benzyl chloride	lb.	1.75	—	2.00
Beta naphthol benzoate	lb.	7.50	—	9.00
Beta naphthol, sublimed	lb.	.85	—	.90
Beta naphthylamin com.	lb.	2.50	—	.....
Dichlor benzol	lb.	.12	—	.18
Dinitrochlorbenzol	lb.	.42	—	.44
Dimethylaniline	lb.	.57	—	.59
Diphenylamine	lb.	1.00	—	1.10
H-acid	lb.	3.00	—	3.50
Metaphenylenediamine	lb.	1.75	—	1.80
Monochlorbenzol	lb.	.22	—	.23
Naphthalene, flake	lb.	.09½	—	.09¾
Naphthionic acid, crude	lb.	1.50	—	1.75
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.	.....	—	.....
Ortho-toluidine	lb.	.90	—	1.00
Para-amidophenol, base	lb.	4.00	—	5.00
Paranitraniline	lb.	1.05	—	1.10
Paraphenylenediamine	lb.	3.50	—	4.00
Para toluidine	lb.	2.00	—	2.10
Phenol, U. S. P.	lb.	.43½	—	.44½
Resorcin, technical	lb.	8.00	—	9.00
Resorcin, pure	lb.	13.50	—	15.00
Salicylic acid	lb.	1.40	—	1.50
Salol	lb.	1.85	—	2.00
Sulphanilic acid	lb.	.32	—	.35
Tolidin	lb.	3.00	—	.....
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3.50	—	....
Corning, Ohio	bbl.	2.60	—	....
Somerset, Ky.	bbl.	2.40	—	....
Wooster, Ohio	bbl.	2.38	—	....
Indiana	bbl.	1.98	—	....
Illinois	bbl.	2.12	—	....
Oklahoma and Kansas	bbl.	2.00	—	....
Caddo, La., light	bbl.	2.00	—	....
Corsicana, Tex., light	bbl.	2.00	—	....
California	bbl.	.98	—	1.32
Gulf Coast	bbl.	1.00	—	....

Fuel Oil

New York	gal.	.10½	—	.....
Pittsburgh	gal.	.07½	—	.10
Oklahoma-Kans.	bbl.	.70	—	1.55
Texas	bbl.	1.60	—	.....
Los Angeles	bbl.	1.45	—	.....
San Francisco	bbl.	1.45	—	.....

Gasoline (Wholesale)

New York	gal.	.24	—	.....
Boston	gal.	.25	—	.....
Pittsburgh	gal.	.24	—	.....
Chicago	gal.	.21	—	.....
Oklahoma	gal.	.23	—	.....
San Francisco	gal.	.20	—	.....

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.13½	—	.14
Cylinder, light	gal.	.21	—	.26
Cylinder, dark	gal.	.18	—	.19
Paraffine, high viscosity	gal.	.29½	—	.30
Paraffine, .903 sp. gr.	gal.	.21½	—	.22
Paraffine, .865 sp. gr.	gal.	.18½	—	.19

Flotation Oils

(Prices at New York)

Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.52	—	....
Pine oil, destructively distilled, sp. gr. 0.920-0.940	gal.	.48	—	.53
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.25½	—	....
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	....
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	....
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—	....
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.22	—	....
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.19	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19	—	....
Wood creosote, ref.	gal.	.30½	—	....

Vegetable and Other Oils

China wood oil	lb.	.21	—	.22
Cottonseed oil, crude	gal.	1.15	—	1.17
Linseed oil, raw, cars	gal.	1.20	—	.....
Peanut oil, crude	gal.	1.20	—	1.21
Rosin oil, first run	gal.	.35	—	.....
Rosin oil, fourth run	gal.	.66	—	.....
Soya bean oil, Manchuria	lb.	.15	—	.15½
Turpentine, spirits	gal.	.47	—	.....

Miscellaneous Materials

Barytes, floated, white, foreign	ton	38.00	—	40.00
Barytes, floated, white, domestic	ton	30.00	—	36.00
Beeswax, white, pure	lb.	.65	—	.68
Carnauba wax, flor.	lb.	.55	—	.....
Casein	lb.	.22	—	.30
Chalk, light, precipitated, English	lb.	.....	—	.....
Feldspar	ton	8.00	—	12.00
Fuller's earth, powdered	100 lb.	1.00	—	1.50
Ozokerite, crude, brown	lb.	.60	—	.70
Ozokerite, American, refined, white	lb.	.75	—	1.00
Red lead, dry, carloads	lb.	.11	—	.12
Rosin, 280 lb.	bbl.	6.50	—	.....
Soapstone	ton	10.00	—	12.50
Talc, American, white	ton	15.00	—	18.00
White lead, dry	lb.	.10	—	.11

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick 1st quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined	ton	40.00	—	55.00
Magnesite, Grecian, dead burned	net ton	85.00	—	90.00
Magnesia brick, Grecian, 9x4½x2½	net ton	135.00	—	140.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, carloads, f.o.b. Niagara Falls, N. Y.	ton	160.00	—	....
Ferrochromium, per lb. of Cr	lb.	.35	—	.40
Ferromanganese, domestic, delivered	ton	375.00	—	400.00
Ferromanganese, English	ton	375.00	—	....
Ferromolybdenum, per lb. of Mo	lb.	4.00	—	4.40
Ferrosilicon, 75 per cent, f.o.b. N. Y.	ton	230.00	—	240.00
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	200.00	—	250.00
Ferrosilicon, 50 per cent, contract	ton	100.00	—	150.00
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.60	—	2.65
Ferrouranium, f.o.b. works, per lb. of U	lb.	7.00	—	7.50
Ferrovanadium, f.o.b. works	lb.	3.25	—	3.50

Ores and Semi-finished Products

Chrome ore, 48 per cent minimum, f.o.b. Cal., per unit	ton	.90		
Manganese ore, 48 per cent and over, per unit	ton	1.00		
Molybdenite, per lb. of MoS_2	lb.	2.20		
Tungsten, Scheelite, per unit of WO_3	ton	26.00		
Tungsten, Wolframite, per unit of WO_3	ton	24.00		
Uranium oxide, 96%	lb.	3.40	—	3.60
Vanadium Pentoxide, 99%	lb.	11.00		
Pyrites, foreign		Nominal		
Pyrites, domestic		Nominal		

INDUSTRIAL

Financial, Construction and Manufacturers' News

New Companies

The Allied Drug & Chemical Corporation, Dover, Del. Capital, $1,000,000. To manufacture chemicals, drugs and kindred products. Incorporators are W. S. Randall, F. A. Armstrong, Wilmington, and C. M. Egner, Elkton, Md.

The Amalgamated Oil-Gas Corporation, New York, N. Y. Capital, $600,000. To manufacture gas making machinery. Incorporators are S. C. P. Dodd, A. F. McCabe and A. E. Moore, 37 Wall Street.

The American International Shipbuilding Corporation, New York, N. Y. Capital, $2,000,000. To operate a shipbuilding works. Incorporators are E. M. Ellsbund and J. E. Manter, New York.

British-American Nitrates Co., Inc., Del. Capital, $2,500,000. To acquire patents in relation to fixation of nitrogen from air. Incorporators are A. J. Gordon, A. J. Knowles, A. Wolf, all of New York.

The Calumet & Massey Copper Company, Inc., Rochester, N. Y. Capital, $250,000. To mine for copper. Incorporators are F. H. Lewis, G. H. Forschler and W. C. Runne, Rochester.

The Chem-Wood Manufacturing Company, New York, N. Y. Capital, $50,000. To manufacture chemical wood and other wood substances. Incorporators are E. J. Welch, R. E. Leavitt and F. Toby, 20 Broad Street.

The Chlorine Control License Corporation, Dover, Del. Capital, $350,000. To manufacture chlorine and other chemicals. Incorporators are S. B. Howard, G. V. Reilly and A. W. Britton, 65 Cedar Street, New York.

The Continental Tire & Rubber Company, Dover, Del. Capital, $300,000. To manufacture rubber tires and other rubber goods. Incorporators are C. L. Rimlinger and F. A. Armstrong, Wilmington.

The Dobbins Core Drill Company, New York, N. Y. Capital, $250,000. To manufacture drilling machines, etc. Incorporators are Thomas H. Dobbins, Roy T. Guthman and R. S. Baldwin, New York.

The Egyptian Manufacturing Company, Newark, N. J. Capital, $100,000. To manufacture disinfectants of various kinds. Incorporators are Alfred C. Eichhorn, Samuel D. Lemon, Newark; and William H. Couper and William J. Smith, East Orange.

F. A. R. Chemical Co., Detroit, Mich. Capital, $10,000. Incorporators are James A. Gordon, Frank A. Ritchie and Nellie A. Martin.

The Galvanizing Corporation of America, Brooklyn, N. Y. Capital, $36,000. To manufacture machinery and chemicals for galvanizing and treating metals. Incorporators are W. Statter, H. Gerson and I. Seegmiller, 29 Broadway, New York.

M. Gottsman & Co., Inc., New York. Capital, $650,000. To deal in pulp, paper and jute mills. Incorporators are Mortimer Brenner, Samuel Schwartzman, Edgar M. Souza.

The Greene-Wolf Company, New York, N. Y. Capital, $20,000. To manufacture engines and similar products. Incorporators are D. Greene, M. J. Baumgarten and G. W. Wolf, 782 East One Hundred and Seventy-fifth Street, Bronx.

George Hall Chemical Co., Everett, N. Y. Capital, $150,000.

The Inter-tube Chemical Company, Dover, Del. Capital, $1,000,000. To manufacture chemicals and allied products. Incorporators are P. E. Britsch, Brooklyn, N. Y.; C. A. Cole, Hackensack, N. J., and A. R. Oakley, Pearl River, N. Y.

The Iprtecu Chemical Company, Newark, N. J. Capital, $200,000. To manufacture chemicals, etc. Incorporators are M. W. Weinberg, O. B. Reichelt and Walter Scholz, Newark.

The Judaline Machine Company, New York, N. Y. Capital, $100,000. To manufacture metal cans, boxes and kindred specialties. J. A. Moore and A. W. Britton, New York, are the incorporators.

The Kyume Co., Wilmington, Del. Capital, $550,000. To manufacture iron, steel, etc.

The Lake Shore Gas Co., Mentor, Ohio. Capital, $100,000. Incorporators are J. B. Morlide, J. McFadyean, F. Seiberling, S. A. Allen and W. E. Slabaugh.

The Livingston Paper Products Company, Brooklyn, N. Y. Capital, $100,000. To manufacture paper boxes of all kinds. Incorporators are J. A. Albrecht, W. Laier and G. W. Cox, 7 Pine Street, New York.

National Manganese Co., Wilmington, Del. Capital, $200,000. To manufacture iron, steel, manganese, etc.

The Natural Products Refining Company, Jersey City, N. J. Capital, $200,000. To manufacture chemicals and allied products. Incorporators are C. V. Steinhart, Harry A. Goman and Stanley L. Weil, Jersey City.

The Newark Waxed Paper Company, Newark, N. J. Nominal capital, $2,000. To manufacture waxed paper, parchment and kindred products. Incorporators are M. Adelson, Leonard E. Kautzman and F. J. Felbel, Newark.

The New Process Rubber Company, West New York, N. J. Capital, $100,000. To manufacture rubber products of various kinds. Incorporators are John Berger, T. Schelberger and Reinhard Brueckner, West New York.

New York Potash Corporation, Dover, Del. Capital, $1,200,000. To acquire lands containing alunite, coal and mine for same.

The Nipissing Mines Co., Ltd., Ontario, Canada. Capital, $6,000,000. Will own and control the Nipissing Mining Co., an operating concern.

The Rhe-Ol Laboratories, Inc., New York, N. Y. Capital, $20,000. To manufacture chemicals, chemical compounds, etc. Incorporators are A. Jacobin, S. S. Bworkin and H. Kopeloff, 2018 Belmont Avenue, Bronx, New York.

Right Spot Lead & Zinc Co., Shawnee, Okla. Capital, $100,000. Incorporators are A. B. Simpson, John W. Wayland and Mark Pierce, Shawnee.

Riverside Refining Co., Portland, Me. Capital, $300,000. Incorporators are A. B. Farnham, P. B. Drew, C. G. Trott, Portland, Me.

Southern Sulphur Company, Houston, Tex. Capital, $300,000. Incorporators are John H. Kirby, B. F. Borner and H. L. Fagin.

The Straight Line Mfg. Co., New York City. Capital, $200,000. To make chemicals and polishes. Incorporators are G. H. Bensen, R. A. Van Vechten, N. H. Phillips, 206 Broadway.

The Thousand Islands Chemical Company, Inc., Gouverneur, N. Y. Capital, $5,000. To manufacture chemicals and allied products. Incorporators are C. M. Woodward, J. K. Young and E. C. Jordan, Gouverneur.

The Trenton Decalcomania Company, Trenton, N. J. Capital, $10,000. To manufacture decalcomanias and similar products. Incorporators are C. Sidney Smith, James Hammond and J. H. Hufnagel, Trenton.

Three Buttes Mining Co., Helena, Mont. Capital, $1,000,000. Incorporators are W. G. Bryan, J. D. Cook, T. K. Baker.

The U. S. Smelting Furnace Co., Belleville, Ill. Capital, $50,000. Incorporators are Geo. B. M. Rogers and Arthur Jones.

The Volcancillos Copper Company, Wilkes-Barre, Pa. Capital, $500,000. To mine for copper and other metals. Incorporators are Martin L. Gallagher, A. W. O'Malley, Wilkes-Barre, and C. G. Boland, Jr., Scranton, Pa.

Western Reserve Chemical Co., Cleveland, Ohio. Capital, $50,000. Ed. A. Noll, incorporator.

Financial

ALUMINIUM CO. OF AMERICA.—The Boston News Bureau has recently issued a statement giving a few facts on the Aluminium Company of America. During 1916 the receipts were $25,940,427, from the sale of 38,656 long tons of aluminium, the sale price averaging 29.96 cents per lb. In addition 11,080 tons of aluminium was delivered to a subsidiary for the production of various aluminium manufactures. The share capital of the company is $20,000,000, and there are about 300 shareholders, many of them employees. The late C. M. Hall, the inventor of the smelting process, owned $5,000,000 in shares in the company. From 1889 to 1898, the capital of the company was $1,000,000, and the only dividends paid were 4 per cent for 1895 and 6 per cent for 1896. From 1899 to 1904, the capital was $1,600,000, and the yearly dividends were 4¼, 8¼, 7¼, 8½, 7¼ and 6 per cent respectively. From 1905 to 1908 the capital was $3,800,000, and the dividends averaged 10 per cent. In 1909 the capital was raised to $20,000,000, and for the next four years the total dividends were 4.2 per cent. For 1914, 1915 and 1916, the dividends were at the rates of 6, 6½ and 10 per cent. The company has a yearly capacity of 75,000 tons. With no imports since the outbreak of the war, the company has been called upon to furnish the entire requirements of America, whereas, formerly 40 per cent of the American consumption was imported from France and England. For 1918 delivery the company has quoted 37c. per lb. as its price, although some sales have recently been made at as high a price as 60c. per lb. Though the nominal capital is $20,000,000, the company has a plant investment of over $80,000,000, approximately $70,000,000 of undivided profits having gone back into the property.

CHILE EXPLORATION COMPANY.—During the month of May, the Chile Exploration Company at Chuquicamata produced 8,250,000 lb. of copper, which is an increase over the output for the previous month of April of 222,000 lb. and over that of May, 1916, of 4,586,000 lb.

The total output of the first five months of 1917 amounted to 38,804,000 lb., and compared with the corresponding period of 1916 was as follows:

	1916	1917
January	2,066,782	7,756,000
February	3,144,480	6,056,000
March	3,536,796	8,714,000
April	3,702,327	8,028,000
May	3,664,000	8,250,000
Total	16,114,385	38,804,000

Construction and Operation

Arkansas

RUSH.—The Lonnie Boy Mining Company has completed arrangements for a mill, which will be built this fall.

California

BERKELEY.—The plant of the Pacific Guano & Fertilizer Company will be enlarged soon by an additional building to be erected on recently purchased property. This concern is working night and day to supply the demand for its products. Large consignments were shipped to the Hawaiian Islands this last week.

Colorado

PUEBLO.—Pueblo is to have a chemical plant for the manufacture of sulphuric acid, according to the plans of the Norcross Chemical Company, a concern incorporated for $1,000,000 under the laws of Colorado and which is financed by Denver and Texas capital. The officers are Robert W. Gunnell, president and general manager; Wirt W. Young, vice-president and works manager; Edward W. Love, secretary-treasurer; Dr. Paul Zurcher, chief chemist. The officers and B. M. Hobbs constitute the board of directors. The offices of the company are in the Ideal Building in Denver. The site of the new plant is understood to be located a few miles west of this city. The plant will be a fifty-ton affair and the Zurcher system of extracting sulphuric acid will be used, the process being patented by the chief chemist of the company and the patent rights being held by the company. Clay beds and factory sites were investigated in several places and the Pueblo site was decided upon on account of the suitableness of the raw material and the excellent railroad facilities of this city. The plant site consists of 80 acres. The raw material to be utilized by the company can be obtained from clay beds in the vicinity of Pueblo, it is stated, and considerable material will be drawn from the Stone City district.

Connecticut

HARTFORD.—The Connecticut Electrical Steel Company has had plans prepared and has been awarded a building permit for the erection of a new foundry building at the junction of Flatbush Avenue and Newfield Street, to cost about $25,000. The building will be 195 x 101 ft., one story high.

Florida

JACKSONVILLE. — Announcement is made that the work on the new plant of the Virginia-Carolina Chemical Company, to be located on the municipal dock property just west of the old St. Johns Mill Road near Talleyrand Avenue, will begin Jan. 1 and that an expenditure of $200,000 will be immediately made to fit up the new factory site, which will add another fertilizer manufactory to Jacksonville's already large list of fertilizer factories. It is conservatively estimated that the company will do between 80,000 and 100,000 tons of business a year.

TAMPA.—Announcement is made by the Florida Brewing Company that in the very near future its big plant will be converted into a large sugar refinery. The plans of the company are only tentative. This city is a logical place to manufacture sugar as it is close to markets in Cuba from which much raw sugar is imported here by the United States.

Idaho

TWIN FALLS.—The Hercules Nitrate Company, with offices here, has been incorporated by O. A. Mathews and J. H. Mathews, to develop large deposit of nitrate in Malheur County, Oregon. The corporation has acquired control of 1280 acres, which is said to be highly impregnated with potash and sodium nitrates, magnesium sulphate and other chemicals.

Illinois

CHICAGO.—The Liquid Carbonic Company has had plans prepared for the erection of a one-story brick addition, about 50 x 200 ft., to its plant at Thirty-first and Kedzie Streets, to cost about $35,000.

CHICAGO.—The Victor Chemical Company, manufacturer of chemicals, has commenced the construction of a one-story power house, about 60 x 220 ft., for works operation, at its plant at Chicago Heights.

EAST ST. LOUIS.—The Monsanto Chemical Company, St. Louis, Mo., has acquired about 90 acres of property at East St. Louis, and is planning for the construction of a plant for the manufacture of chemicals. It is said the works will employ about 500 hands for initial operations.

Maryland

BALTIMORE.—The work of constructing a pipe line more than one mile long from the plant of the Curtis Bay Chemical Company at Stone House Cove to the Curtis Bay Distillery at Curtis Bay has begun. The line will be used to carry refuse from molasses after it has been used in manufacturing alcohol to the distillery, where it is to be converted into various products. When the distillery first opened the refuse was thrown away, but now it is being utilized at the chemical plant, until recently devoted to the manufacture of acetone. A right of way has been secured for the pipe line through the various industrial plants in the section and also through the yards of the Baltimore & Ohio Railroad. The refuse will flow by gravity, no pumps being used. It will be pumped into a high storage tank at the distillery. Just now it is being taken to the chemical plant in tank cars.

Massachusetts

MILLBURY.—The Millbury Steel Foundry Company has just awarded E. D. Ward, general contractor of Worcester, the contract for extensive additions to its plant on Howe Avenue, which will mean trebling its production and doubling its working force.

Michigan

DETROIT.—A despatch from Detroit says that the Henry Ford & Son Company has let to the George A. Fuller Company a contract for building blast furnaces on the River Rouge, near there. The cost will be $20,000,000, of which $8,000,000 will be spent for labor. Later a mammoth tractor plant will be developed. The furnaces with a capacity of 1000 tons daily will furnish all the iron and steel used both in Ford cars and in the tractors.

Montana

BAKER.—Gas Products Company, according to R. H. Deebach, manager, plans erection of a plant in Baker for the manufacture of carbon black. First unit will consist of eight sheds, and will produce 3000 lb. annually, the plant to be enlarged later to produce 24,000 lb.

MALTA.—It is stated that a fiber flax mill may be constructed in this city by the Havre Flax Mills Company.

New Jersey

NEWARK.—The Balbach Smelting & Refining Company, 580 Market Street, is planning for the erection of a new two-story addition at Hamburg Place and Curry Street, to cost about $8,000.

NEWARK.—The F. W. Devoe & C. T. Raynolds Company, 223 New Jersey Railroad Avenue, has awarded a contract for the construction of a new one-story brick addition to its plant. Henry M. Doremus Company, 36 Orange Street, Newark, is the contractor.

NEWARK. — The Butterworth-Judson Corporation, Avenue R, is having plans prepared for the construction of one and two-story additions to its plant, brick and steel, about 45 x 325 ft., and 69 x 225 ft., respectively, to cost approximately $125,000.

NEWARK.—The Metal Products Company, 790 Broad Street, manufacturer of twist drills and allied products, has announced the removal of its office to 32 Broadway, New York.

JERSEY CITY.—The Seydel Manufacturing Company, 88 Forest Street, manufacturer of chemicals, has had plans prepared for the construction of a new two-story manufacturing plant, about 80 x 170 ft.

JERSEY CITY.—The William T. Baker Company, Inc., 147 Pacific Avenue, has had plans prepared for the construction of a one-story reinforced-concrete addition, about 60 x 100 ft., to its varnish manufacturing plant. The structure is estimated to cost about $20,000. James Mitchell, Inc., 76 Montgomery Street, Jersey City, is the contractor.

PERTH AMBOY.—The Raritan Copper Company, foot of Elm Street, is building a new two-story addition to its plant, about 40 x 100 ft.

CLIFTON.—Fire recently destroyed a portion of the plant of the M. J. Levine Company, Main Avenue, manufacturer of aeroplane varnish, waterproofing materials, etc., with loss estimated at $30,000.

HILLSIDE.—Riches, River & Company, 30 Church Street, New York, manufacturers of chemicals, have had plans prepared for the erection of a one and two-story local plant, about 75 x 100 ft. Taylor & Mosley, 40 Wall Street, New York, are the architects.

ELIZABETH.—Fire recently destroyed a portion of the plant of the Bayway Chemical Company, with loss estimated at $10,000. It is said the structure will be rebuilt.

BAYONNE.—The National Sulphur Company has taken out a building permit for the construction of a one-story addition to its plant at Constable Hook.

PATERSON.—The Commonwealth Chemical Corporation of New York will erect soon at East Forty-second and Forty-third Streets, Paterson, a plant to cost more than $100,000. The city of Paterson held title to the property because of unpaid taxes of $3,347.36. The Paterson Board of Finance has agreed to deed it to the corporation on the payment of the taxes, upon the condition that it erect a plant costing not less than $100,000, work on its construction to commence within six months.

New York

NIAGARA FALLS.—The Niagara Alkali Company is preparing plans for a new $30,000 benzol plant. The company last week increased its capitalization from $1,750,000 to $5,000,000. The company has recently made several additions to its plant.

MICHIGAN FALLS.—The City Council granted the application of the Hydro Fats, Inc., of Buffalo to locate on a tract of Buffalo Avenue land owned by the Niagara Falls Power Company for the purpose of manufacturing edible fats from cocoanut oils. The company expects to obtain hydrogen from the Hooker Electrochemical Co.

LONG ISLAND CITY.—The Patterson-Sargent Company, Wason and Hamilton Streets, Cleveland, Ohio, has purchased a plot of 14,000 sq. ft. at Van Dam Street and Hunterspoint Avenue, and is having plans prepared for the erection of a five-story reinforced concrete factory building, for paint and varnish manufacture.

NEW YORK.—The American Can Company, 120 Broadway, will build a new two-story addition to its works on McWhorter Street, Newark, N. J. The structure will be about 50 x 120 ft.

POTSDAM.—The Racquette River Paper Company, manufacturer of paper, has awarded a contract to H. Wales Lyons, New London, Conn., for the construction of a two-story brick and reinforced-concrete addition to its plant, about 100 x 150 ft., to cost about $25,000. George Sisson is president of the company.

NEW YORK.—The Burns Manufacturing Company, 25 Beaver Street, manufacturer of chemicals, is planning for the erection of a new plant on Paterson Plank Road, East Rutherford, N. J.

Ohio

CLEVELAND.—The Ohio Bronze Powder Company, 1120 East 152d Street, has increased its capital stock from $50,000 to $200,000 for the purpose of increasing its capacity. The company manufactures a complete line of gold and aluminium products. Purchase of new machinery will take place this fall and work will begin in the spring on a two-story building, 30 x 100 ft., that will contain offices and a warehouse. The company owns a piece of land 80 x 400 ft., supplied with an industrial spur from the Nickel Plate.

TOLEDO.—The Burt Foundry Company, 934 Hastings Street, has secured a building permit to erect a $32,500 foundry addition on Bush Street, near the W. & L. E. R. Plant will be 200 x 200 ft.

Oklahoma

BAXTER.—The Crescent Lead & Zinc Company, which has several leases south of Baxter, Okla., has recently leased a portion of its land to a company that plans the immediate construction of a new tailing mill. An investigation of some of the chat piles that were left when different companies operated the ground a number of years ago is said to show a good blende content in the chats which it was impossible to obtain by former inefficient methods of concentration.

Oregon

PORTLAND.—The Western Reduction Company, Twenty-fourth Street and Nicolai Avenue, Portland, Ore., is building a plant and installing equipment for a ferro-alloy smelter. The building is 100 ft. by 50 ft., with a 100-ft. addition to go up as soon as the present work is completed. There are three electric furnaces to be installed now, making a total capacity about ten tons per day. The company will make ferro-manganese, using a Japanese ore. The furnaces are of local construction. Mr. A. T. Coakley is the metallurgist in charge.

VALE.—American Mineral Products Company is completing plans for its proposed nitrate plant at this point, to cost $40,000. Company controls nitrate deposits over 2500 acres, said to be from 50 to 60 ft. deep and average 3 per cent nitrate. Capacity of the proposed plant will be 200 tons daily, producing six tons daily of the commercial product.

ROSEBURG.—The Umpqua Copper Company has been incorporated in this city, to continue development work on eight mining claims in Douglas County. More than $25,000 has been spent thus far in development.

Pennsylvania

SHARON.—Improvements costing close to $3,000,000 will probably be completed at Farrell works of the Steel Corporation within 60 days. Improvements include 10 hot mills, new power plant, new ore bridges and bins at blast furnace and a modern bar mill. The skelp mill also was rebuilt.

PHILADELPHIA.—Fire recently destroyed a portion of the plant of George D. Wetherill & Company, 114 North Front Street, manufacturers of paints and varnishes, with loss estimated at about $50,000. The plant will be immediately rebuilt.

PHILADELPHIA.—The Pecora Paint Company, Fourth and Venango Streets, manufacturer of paints, varnishes, etc., has had plans prepared for the erection of additions to its plant.

DAHOGA.—Fire recently destroyed the stillhouse of the McKean Chemical Company, with loss estimated at $90,000. Headquarters of the company, which specializes in the production of wood alcohol and acetate of lime, are at 112 West Fourth Street, Williamsport.

CARLISLE.—The Carlisle Tire & Rubber Company is planning the immediate installation of machinery and equipment in the local factory building recently leased for the manufacture of its products. Charles S. Mooney heads the company.

WILLIAMSPORT.—The Lycoming Rubber Company has awarded a contract for the construction of a three-story addition, about 48 x 50 ft., to its plant on Rose

Street, near Erie Avenue, to cost about $10,000. Jacob Gehron, 1228 Ann Street, Williamsport, has the contract for erection.

POTTSTOWN.—The Light Manufacturing & Foundry Company, manufacturer of aluminium ware, is planning for the construction of an addition to its plant to increase the capacity.

Texas

HOUSTON.—The Simms-Sinclair oil interests have paid the sum of $289,681 for a 712-acre tract on the Ship Channel below the Turning Basin. For months these interests have been seeking a refinery site in the vicinity of Houston.

TEXAS CITY.—Work has begun on a grease plant at the refinery of the Pierce-Fordyce Oil Association at Texas City for the manufacture of all grades of lubricants and greases. The installation of the machinery and the instruction of the men who are to operate the new plant are under the direct supervision of J. H. Brinkmeyer of St. Louis, who was sent from the plant of the Pierce Oil Corporation in that city.

Utah

OGDEN.—Construction of a plant for milling zinc and lead ores by the Lake View Mining Company at Promontory Point has been arranged for by directors of the corporation, who made an agreement with A. O. Zimm of Los Angeles for the installation, which will cost approximately $20,000.

Virginia

IVANHOE.—The National Carbide Company, incorporated with $350,000 capital stock, has purchased a site of twenty-two acres, a little over a mile from this place, and will commence at once on the construction of an immense plant for the manufacture of carbide and for burning agricultural lime. Contracts have been signed up for the building of the plant and also for the larger part of the machinery to be installed therein. Large lime quarries have been leased, and there will be no delay in setting the plant to work when the buildings are ready.

Washington

SEATTLE.—The West Coast Chemical Company, with Phillips A. Carleton, president, and George N. Calkins, secretary-treasurer, has recently purchased 200 acres of coal lands near Cumberland, Wash. Company plans extensive additions to its chemical plant in Seattle, and the erection of a large plant for the manufacture of coal tar by-products. The company is the only manufacturer of the by-products of coal tar on the Pacific coast, and the new plant at Cumberland will be second of that kind in this section. The company's present plant, of which the manufacture of dyes is the most important branch has rapidly increased in importance since the European war. President Carleton states that with the expansion of the present plant, and opening of the proposed plant at Cumberland, between 400 and 500 men will be employed at the mines, and the force at the Seattle plant will be increased from 35 to several hundred.

SEATTLE.—The Olympic Portland Cement Company, here, will construct a coal handling plant at its cement mills in Bellingham, Wash., to cost $20,000. Plant will have capacity of 150 tons daily, as the oil fuel boilers will be converted into powdered coal burners.

SPOKANE.—Commonwealth Mining Company, operating near Hayden Lake, Idaho, will erect a concentrating plant, the first unit to have capacity of 60 tons. An 80-hp. boiler and four drill compressor will be a part of the new equipment.

WENATCHEE.—American Mill & Produce Company are developing the silica industry in Grant County. The concern recently acquired lease on a half section of state land, and have fitted up a plant to manufacture finished products.

NORTHPORT.—Northport Power & Light Company has recently incorporated for the purpose of supplying electrical energy to the Northport Smelting & Refining Company, and to mining concerns in the district north of Spokane. The electric power will succeed steam at the Northport smelter, which plans to extend its operations.

VALLEY.—The Northwest Magnesite Company, here, will shortly place its manufacturing department in commission. The company's plant investment represents $26,000, and will be used to refine magnesite and manufacture magnesite specialties. Shipments for each month are showing gradual increase.

IRONDALE.—After an idleness of five years, the blast furnace at Irondale, a remnant of the steel mills of the defunct Western Steel Corporation, has been placed in operation by the Pacific Coast Steel Company. The rolling mills of the old company have been removed by the Pacific Coast Steel Company to its plant in Youngstown. The Irondale furnace will employ 75 men, and will use for the present, the Chinese ore brought from China by the Western Steel Corporation. It is stated that later on local ore will be used.

SEATTLE.—West Coast Tanning Company, with a plant at 1138 West Sixty-fourth Street, Seattle, has been reincorporated as the North Coast Tanning Company, and important extensions will be made to the company's plant. J. C. Ford, managing director.

Manufacturers' Catalogs

LINK-BELT COMPANY, Chicago, Ill., has issued a pamphlet on "Casings for Link-Belt Silent Chain Drives," describing silent chains.

LINK-BELT COMPANY, Chicago, Ill., has issued a pamphlet on "Link-Belt Electric Hoists," describing construction and operation.

WORTHINGTON PUMP & MACHINERY CORPORATION, New York, N. Y., has issued a pamphlet on "The Worthington Steam Pump," describing outside packed plunger pattern pumps, for general service.

WORTHINGTON PUMP & MACHINERY CORPORATION, New York, N. Y., has issued a pamphlet on "Worthington Volute Centrifugal Pumps."

WORTHINGTON PUMP & MACHINERY CORPORATION, New York, N. Y., has issued a pamphlet on "Worthington Turbine Pumps for High Head Service," describing the turbine pump and principle of operation.

BRAEMER AIR CONDITIONING CORPORATION, Philadelphia, Pa., has issued a pamphlet on "Braemer Humidifiers and Dehumidifiers," describing air conditioning apparatus for industrial processes of every description.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO., East Pittsburgh, Pa., has issued a pamphlet on "Westinghouse Synchronous Motors," describing power factor correction.

AUTOMATIC SPRINKLER CO. OF AMERICA, 123 William Street, New York, N. Y., has issued a pamphlet entitled the "Pursuit of Safety."

SHARPLES SPECIALTY COMPANY, West Chester, Pa., has issued a pamphlet on "Super-Centrifugal Treatment of Varnish," describing labor, force, cost, capacities, installation.

THE OLIVER CONTINUOUS FILTER CO., San Francisco, Cal., has issued a pamphlet on "Olive Filters," describing use, construction, operation.

N. Y. REVOLVING PORTABLE ELEVATOR CO., Jersey City, N. J., has issued a pamphlet on "The Steel Giant" elevator.

THE BRAUM CORPORATION, Los Angeles, Cal., has issued pamphlets on "Iron Ore, Crushers, Cement Laboratory Equipment, and Coal Testing Laboratory Equipment."

REPUBLIC FLOW METERS CO., Chicago, Ill., has issued a pamphlet "Human Weakness vs. Machine Accuracy."

Other New Publications

BIBLIOGRAPHY OF RECENT LITERATURE ON FLOTATION OF ORES.—July to December, 1916. Compiled by D. A. Lyon, O. C. Ralston, F. B. Laney and R. S. Lewis. Washington Government Printing Office.

STRONTIUM IN 1916. By James M. Hill, U. S. Geological Survey Bulletin. Washington Government Printing Office. Published Sept. 6, 1917.

FULLER'S EARTH IN 1916. By Jefferson Middleton. U. S. Geological Survey. Washington Government Printing Office. Published Sept. 4, 1917.

SALT, BROMINE, AND CALCIUM CHLORIDE IN 1916. By Ralph W. Stone, U. S. Geological Survey. Washington Government Printing Office, 1917. Published Sept. 8, 1917.

FELDSPAR IN 1916. By Frank J. Katz, U. S. Geological Survey. Washington Government Printing Office. Published Aug. 25, 1917.

GRAPHITE IN 1916. By Henry R. Ferguson, U. S. Geological Survey. Washington Government Printing Office, 1917. Published Aug. 13, 1917.

CREOSOTED WOOD STAVE PIPE AND ITS EFFECT UPON WATER FOR DOMESTIC AND IRRIGATION USES IN 1917. By H. K. Benson. Prepared under a cooperative agreement between the Bureau of Industrial Research, the Forest Products Laboratory of the University of Washington, the West Coast Lumberman's Association, the Association of Creosoting Companies of the Pacific Coast, the Water and Engineering Departments of the City of Seattle, the Pacific Coast Pipe Company, and the Pacific Creosoting Company. Published by the University of Washington.

Manufacturers' Notes

CASTNER CHANGES HANDS.—The Mathieson Alkali Works, Inc., of Saltville, Va., has taken over the Castner Electrolytic Alkali Co., of Niagara Falls, N. Y., and the plant will hereafter be known as the Niagara Works of the Mathieson Alkali Works, Inc.

NEW JERSEY ZINC BUYS OFFICE SITE.—The New Jersey Zinc Co., whose present office is at 55 Wall Street, New York, is negotiating for the block between Maiden Lane, Front, Fletcher and Water Streets as a site for a new office building, seven stories high. Several parcels of the block are understood to have been already acquired and negotiations are under way for the remainder.

JAPANNING AND DRYING OVENS.—The Bradford-Ackermann Corporation, Forty-second Street Building, New York City, announce that they have been appointed the Eastern Sales Office for Young Brothers Company, Detroit, Mich.

The sale of Young ovens, for japanning and drying purposes, will in the future be handled by this eastern office for the New England States, New York, New Jersey, Maryland, Delaware and eastern Pennsylvania. An engineering department will likewise be available for manufacturers in the East who are interested in quick drying and baking processes, and special oven designs will be offered to meet various requirements.

THE STANDARD ASPHALT & REFINING COMPANY of Chicago, Ill., has purchased the plants, trade marks and good will of the Sarco Petroleum Products Company. The Cities Service Company of 60 Wall Street, New York City, is the new interest in back of this company, although the management remains essentially the same as before the change.

Mr. Charles Muller, who was an executive of the former company, now becomes manager. He has been associated with the old company for ten years and has risen through the ranks to his present position and is well known in business and financial circles in Chicago.

Mr. Robert F. Trumbull has been promoted to manager of the Railway and Building Materials Department. He has been in the service of the old company for eight years in this department. By constant contact with the trade during that time he is intimately acquainted with its requirements for asphalt materials.

WORTHINGTON PUMP & MACHINERY CORPORATION announces the opening of a new branch sales office at American Trust and Savings Bank Building, Birmingham, Ala., to take care of a portion of the very large territory hitherto controlled by the Atlanta Office. Mr. Edward Stauverman, formerly with the Atlanta office, will be in charge of the Birmingham office as manager. The territory controlled by the Birmingham office will be of all the State of Alabama, excepting the following counties: Choctaw, Clark, Monroe, Washington, Conecuh, Mobile, Baldwin and Escambia. All of the State of Florida, excepting the following counties: Okaloosa, Escambia and Santa Rosa. All of that portion of the State of Georgia south of the Seaboard Air Line, running from Columbus, Ga., to Savannah, Ga.

All inquiries originating in this territory should hereafter be addressed to the Birmingham office, located at American Trust & Savings Bank Building, instead of to Atlanta, as heretofore.

The States of North and South Carolina and that portion of Georgia north of the Seaboard Air Line will continue to be served by the Atlanta office under the management of Mr. A. W. Jones.

SOYA BEAN OIL.—A special freight train consisting of twenty-seven tank cars of soya bean oil left the Pacific Coast on Sept. 22 for the East via the Union Pacific Railroad. This is stated to set a new record for single shipments of soya bean oil. The shipment is consigned to Marden, Orth & Hastings Corporation, 61 Broadway, New York.